

ISO 9001:2015

AICTE-CII: GOLD Category Institute

NAAC-'A' Grade Institute (CGPA: 3.21)

NIRF-2020 Rank Band: 201-250



**KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE**

Opp : Yerragattu Gutta, Hasanparthy (Mandal), WARANGAL - 506 015, Telangana, INDIA.

काकतीय प्रौद्योगिकी एवं विज्ञान संस्थान, वरंगल - ५०६ ०१५ तेलंगाना, भारत  
కాకతీయ సాంకేతిక విజ్ఞాన శాస్త్ర విద్యాలయం, వరంగల్ - ౫౦౬ ౦౧౫ తెలంగాణ, భారతదేశము

(An Autonomous Institute under Kakatiya University, Warangal)

(Approved by AICTE, New Delhi; Recognised by UGC under 2(f) & 12(B); Sponsored by EKASILA EDUCATION SOCIETY)

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## DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

### **B. TECH.CURRICULUM**

**ACADEMIC YEAR: 2024-25**

## **DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

**Revised Undergraduate Rules and Regulations-2024 (URR24)**  
**In accordance with the National Education Policy 2020**  
**w.e.f. A.Y. 2024-25**

**Regulations Governing the**  
**Choice-Based Credit System and**  
**Multiple Entry and Multiple Exit Options**  
**with**  
**Competency-Focused Outcome-Based Curriculum (CF-OBC)**



KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE, WARANGAL - 506 015, TELANGANA

(UGC Autonomous Institute Under Kakatiya University, Warangal)

# 1<sup>st</sup> Semester Syllabus

**B. Tech (ECE) -CURRICULUM (KITSW-URR24)**  
**SEMESTER-WISE CURRICULUM WITH SCHEME OF INSTRUCTIONS**

**Abbreviations**

|   |                 |   |                                           |
|---|-----------------|---|-------------------------------------------|
| L | Lecture Hours   | O | Outside the Class Work (Self-Study) Hours |
| T | Tutorial Hours  | E | Total Engagement in Hours                 |
| P | Practical Hours | C | Credit Assigned                           |

**I SEMESTER**

**Stream – I**

| S. No.                                                                                                                                                                        | Category | Course Code       | Course Title                                                               | Lectures/week |   |   |    |    | Credits |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------|----------------------------------------------------------------------------|---------------|---|---|----|----|---------|
|                                                                                                                                                                               |          |                   |                                                                            | L             | T | P | O  | E  | C       |
| -                                                                                                                                                                             | IKSC     | U24IK100          | AICTE Mandated Student Induction Programme<br>(Universal Human Values - I) |               |   |   |    |    | -       |
| 1                                                                                                                                                                             | BSC      | U24MH101          | Differential Calculus and Ordinary Differential Equations                  | 2             | 1 | - | 6  | 9  | 3       |
| 2                                                                                                                                                                             | BSC      | U24PY102E         | Engineering Physics<br>(for ECE)                                           | 2             | 1 | 2 | 5  | 10 | 4       |
| 3                                                                                                                                                                             | PCC      | U24EC103          | Switching Theory and Logic Design                                          | 2             | 1 | - | 4  | 7  | 3       |
| 4                                                                                                                                                                             | ESC      | U24EC104          | Programming for Problem Solving with C                                     | 2             | 1 | 2 | 5  | 10 | 4       |
| 5                                                                                                                                                                             | ESC      | U24EE105B         | Basic Electrical Engineering<br>(Common to ECE & ECIE)                     | 2             | 1 | 2 | 5  | 10 | 4       |
| 6                                                                                                                                                                             | VAC      | U24CY106          | Environmental Studies                                                      | 2             | - | - | 3  | 5  | -       |
| 7                                                                                                                                                                             | AEC      | U24AE107          | IDEA Lab Makerspace                                                        | -             | - | 2 | 2  | 4  | 1       |
| 8                                                                                                                                                                             | ELC      | U24EL108          | Practicum-1                                                                | -             | - | - | 4  | 4  | 1       |
| 9                                                                                                                                                                             | VAC      | U24VA109X<br>XXXX | SEA - I / SAA-1                                                            | -             | - | - | 2  | 2  | 1       |
| 10                                                                                                                                                                            | AEC      | U24AE110          | Expert Talk Series-1                                                       | -             | - | - | 1  | 1  | 1       |
| Total:                                                                                                                                                                        |          |                   |                                                                            | 12            | 5 | 8 | 37 | 62 | 22      |
| Summer/ Inter-Sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet) |          |                   |                                                                            | -             | - | - | -  | -  | -       |

## DIFFERENTIAL CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS

|                                        |                  |                                       |            |
|----------------------------------------|------------------|---------------------------------------|------------|
| <b>Class:</b> B.Tech. I -Semester      |                  | <b>Branch:</b> Common to all branches |            |
| <b>Course Code:</b>                    | <b>U24MH101</b>  | <b>Credits:</b>                       | <b>3</b>   |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>2-1-0-6-9</b> | <b>CIE:</b>                           | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36 Hrs</b>    | <b>ESE:</b>                           | <b>40%</b> |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

**LO1:** convergence of an infinite series and differential calculus

**LO2:** partial differentiation and its applications

**LO3:** differential equations of first order and first degree, along with certain applications

**LO4:** higher order linear differential equations and applications

|               |              |
|---------------|--------------|
| <b>UNIT-I</b> | <b>9 Hrs</b> |
|---------------|--------------|

**Infinite Series:** Sequences, Series, General properties of series, Series of positive terms, Comparison Tests-Limit form, Integral test, D'Alembert's Ratio test, Cauchy's root test

**Differential Calculus and its applications:** Fundamental theorems-Rolle's theorem (Geometrical interpretation), Lagrange's mean value theorem (Geometrical interpretation), Cauchy's mean value theorem, Taylor's theorem (Generalised mean value theorem), Expansion of functions- Maclaurin's series, Taylor's series, Maxima and Minima-Conditions, Practical problems (rectangle, right circular cylinder, cone)

**Self-Learning Topics (SLTs):** Review of basic concepts of limit, continuity and differentiability [Reference 1: topic (3.1,3.2,3.5,4.1)], Alternating series [(Text 1: topic 9.12, Solved problems: 9.16,9.17, Practice problems: exercise 9.7(1, 7)], Additional problems on fundamental theorems [(Text 1: topic 4.3, Solved problems: 4.13(i),4.14,4.17, Practice problems: exercise 4.4 (1(i),1(ii), 3(ii), 10(i), 10(ii))], Additional problems on Maclaurin's series [(Text 1: topic 4.4, Solved problems: 4.20, Practice problems: exercise 4.5 (3, 5)]

|                |              |
|----------------|--------------|
| <b>UNIT-II</b> | <b>9 Hrs</b> |
|----------------|--------------|

**Partial differentiation and its applications:** Functions of two or more variables, Partial derivatives, Total derivative, Change of variables, Jacobians, Functional relationship, Geometrical interpretation-Tangent plane and Normal to a surface, Taylor's theorem for function of two variables (without proof), Errors and approximations, Total differential, Maxima and minima of function of two variables, Lagrange's method of undetermined multipliers, Differentiation under the integral sign

**Self-Learning Topics (SLTs):** Leibnitz rule of Differentiation under the integral sign for variable limits [(Text 1: topic 5.13(2)), Solved problems: 5.54, Practice problems: exercise 5.11 (1)], Additional problems on maxima and minima of function of two variables [(Text 1: topic 5.11 (1), Solved problems: 5.42, 5.43, Practice problems: exercise 5.10 (1(i),1(ii),1(iii))], Additional problems on Lagrange's methods of undetermined multipliers [(Text 1: topic (5.12), Solved problems: 5.45, 5.48, Practice problems: exercise 5.10 (3(i),3(ii))]

| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9 Hrs |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <p><b>Differentialequations offirstorder (DE):</b>Reorientationofdifferential equationsof firstorder and firstdegree(Formation of a differentialequation, variables separable method, homogeneous equations,Linear equations),Exactdifferential equations,Equations reducibletoexactequations</p> <p><b>Applicationsofdifferentialequationsoffirstorder:</b>Orthogonal trajectories - Orthogonal trajectories of the family of curves <math>f(x, y, c) = 0</math>, Physical Applications-Motion of a boat across a stream, Resisted motion, Velocity of escape from the earth, Simple electric circuits - RL series circuit, Newton's law of cooling, Rate of decay of radioactive materials, Rate of growth of population</p> <p><b>Self-Learning Topics (SLTs):</b> Review of DEs of first order (Text 1: topic 11.1, 11.2, 11.3, 11.4,11.5), Solutions of Non-exact DEs by Inspection Method [(Text 1: topic 11.12(1), Solved Problems: 11.30, Practice problems: exercise 11.8 (1,3)], Additional problems on Non-exact DEs [(Text 1: topic 11.12(2,3,4,5), Solved problems: 11.33,11.35,11.36, Practice problems: exercise 11.8 (9,15)], Orthogonal Trajectories of family of curves in polar coordinates [(Text 1: topic 12.3(3), Solved problems:12.7,12.8, Practice problems: exercise 12.2(9,10)].</p> |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 9 Hrs |
| <p><b>Linear differential equations:</b> Lineardifferential equationswith constantcoefficients, Rules for finding complementary function, Inverse operator, Rules for finding the particular integral(<math>Q=e^{ax}</math>, <math>\sin(ax+b)</math> or <math>\cos(ax+b)</math>, <math>x^m</math>and <math>e^{ax}V(x)</math>), Methodofvariationofparameters, Linear dependence of solutions</p> <p><b>Applications oflineardifferential equations:</b>Simple harmonic motion, Simple pendulum, Oscillations of a spring, Oscillatory electrical circuit-LCR circuit, Electro-mechanical analogy</p> <p><b>Self-Learning Topics (SLTs):</b>Finding the particular integral of <math>Q(X) = X^m V(X)</math> [(Text 1: topic 13.7, Solved problems: 13.16,13.17,13.19, Practice problems: exercise 13.2 (21,22)],Additional problems on method of variation of parameters [(Text 1: topic 13.8(1), Solved problems: 13.25, 13.26, Practice problems: exercise 13.3(1,5)],Cauchy's homogeneous linear differential equation [(Text 1: topic 13.9(1), Solved problems: 13.31,13.34, Practice problems: exercise 13.4(3,6,9)].</p>                                                                                                                                                                                   |       |
| <p><b>Course Learning Outcomes (COs):</b><br/> After completion of this course, the students should be able to...</p> <p><b>CO1:</b>Examine the convergence of a series and interpret the mean value theorem</p> <p><b>CO2:</b> Apply partial differentiation to functions of several variables in solving various engineering problems</p> <p><b>CO3:</b> Apply appropriate methods of differential equations of first order and first degree to solve real-life engineering problems</p> <p><b>CO4:</b> analyse the solutions of higher-order linear differential equation with constant coefficients</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |
| <p><b>TextBook(s):</b><br/> 1. Grewal, B.S., <i>Higher Engineering Mathematics</i>, 44thed.Khanna Publishers, Delhi, 2017</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| <p><b>Reference Book(s):</b><br/> 1. Shanti Narayan, Dr Mittal P.K, <i>Differential Calculus</i>, S. Chand &amp; Co., New Delhi, 1sted. Reprint 2014<br/> 2. Kreyszig E, <i>Advanced Engineering Mathematics</i>, 10thed. Inc, U.K, John Wiley&amp;Sons, 2020<br/> 3. S.S. Sastry, <i>Engineering Mathematics, Vol.II</i>, Prentice Hall of India, 3rded., 2014</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| <p><b>Web and Video link(s):</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |

1. <https://youtu.be/4EYko9rdF7g?si=WUu12NPTEL> Video Lecture on Infinite series by Prof. S.K.Ray, Professor of Mathematics, IITK Kanpur.
2. [https://youtu.be/0apMXhWG\\_W8?si=M-abw2Gq3buX5HLMNPTEL](https://youtu.be/0apMXhWG_W8?si=M-abw2Gq3buX5HLMNPTEL) Video Lecture on Fundamental Mean Value Theorems by Prof. Jithendra Kumar, Professor of Mathematics, IITK Kharagpur.
3. <https://youtu.be/6r5jfT8xrXM?si=ryLXYVJr4-iUkdIV>; NPTEL Video Lecture on Exact Differential Equations, Prof. Jithendra Kumar, Professor of Mathematics, IIT Kharagpur.
4. [https://youtu.be/kbGhrqV9AOM?si=yGyK\\_V7kJKGa3OaRNPTEL](https://youtu.be/kbGhrqV9AOM?si=yGyK_V7kJKGa3OaRNPTEL) Video Lecture on Orthogonal Trajectories of family of curves by Prof. Aditya Sharma, Professor of Physics, IITSE Bhopal.
5. <https://youtu.be/btOCUmJkrrg?si=zq3nB00kplm7b5se>; NPTEL Video Lecture on Higher Order Linear Differential Equations, Prof. Jithendra Kumar, Professor of Mathematics, IIT Kharagpur.

| Course Articulation Matrix (CAM): |            |      |      |      | U24MH101 DIFFERENTIAL CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|--------------------------------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                                                               | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24MH101.1 | 2    | 2    | 1    | 1                                                                  | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO2                               | U24MH101.2 | 2    | 2    | 1    | 1                                                                  | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO3                               | U24MH101.3 | 2    | 2    | 1    | 1                                                                  | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO4                               | U24MH101.4 | 2    | 2    | 1    | 1                                                                  | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| U24MH101                          |            | 2    | 2    | 1    | 1                                                                  | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |            |      |      |      |                                                                    |      |      |      |      |      |       |       |       |       |

| ENGINEERING PHYSICS (for ECE)                                                                                                                                                                                                                                                                                                                                                                                                  |            |             |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-----|
| Class: B.Tech. I -Semester                                                                                                                                                                                                                                                                                                                                                                                                     |            | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                   | U24PY102E  | Credits:    | 4   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                        | 2-1-2-5-10 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                | 60 Hrs.    | ESE:        | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                                                                                                              |            |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                                                                                                         |            |             |     |
| LO1:basic principles, operation of lasers and optical fibres                                                                                                                                                                                                                                                                                                                                                                   |            |             |     |
| LO2:properties of dielectric, magnetic and superconducting materials                                                                                                                                                                                                                                                                                                                                                           |            |             |     |
| LO3: semiconductor materials and semiconductor diode characteristics                                                                                                                                                                                                                                                                                                                                                           |            |             |     |
| LO4:bipolar junction transistors (BJTs) and operation of special diodes                                                                                                                                                                                                                                                                                                                                                        |            |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                                                                                                               |            |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                         |            | 9 Hrs       |     |
| <b>Applied Optics and Lasers:</b> Principles of interference, Diffraction phenomena and applications (qualitative); Difference between conventional light and laser, Basic principles and characteristics of lasers, Absorption, Spontaneous and stimulated emission, Population inversion, Pumping methods, Optical resonator; Types of lasers- Ruby laser, He-Ne laser; Applications of lasers                               |            |             |     |
| <b>Fibre Optics:</b> Introduction, Total internal reflection, Optical fiber construction, Numerical aperture and acceptance angle; Types of optical fibers - Step index and graded index, Single and multimode, V-number; Attenuation losses in optical fibers; Fiber optic communication system, Applications of optical fibers– Endoscopy, Fiber optic sensors (temperature and displacement)                                |            |             |     |
| <i>Self Learning Topics (SLTs):</i> Concept of wave and basic concepts- amplitude, wavelength, frequency, phase, phase angle and general wave equation (Text1: topic 1.9), types of waves (Text1: topic 1.10), reflection laws (Text1: topic 1.11).                                                                                                                                                                            |            |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                        |            | 9 Hrs       |     |
| <b>Dielectric materials:</b> Introduction, Permittivity, Dielectric constant, Polarization, Dielectric polarization mechanisms- Electronic, Ionic, Orientational and Space charge polarization (qualitative); Dielectric breakdown                                                                                                                                                                                             |            |             |     |
| <b>Magnetic and Superconducting materials:</b> Introduction, Permeability, Magnetization, Susceptibility, Origin of magnetism, Bohr magneton, Ferro, Antiferro and ferri magnetic materials, Hysteresis, Soft and hard magnetic materials, Applications of magnetic materials; Superconductivity, Meissner effect, Transition temperature, Isotope effect, Type-I and type-II superconductors, Applications of superconductors |            |             |     |
| <i>Self-Learning Topics (SLTs):</i> Polarization (Text3: topic 5.3), properties of dielectric (Text3: topic 5.6), Eddy currents (Text3: topic 6.5), classification of dielectric materials (Text1: topic 40.22), magnetization, susceptibility& their relations (Text1: topic 41.2), London penetration depth (Text1: topics 42.4.7), Solved problems (Text1: Prob 42.9 to 42.14)                                              |            |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                       |            | 9 Hrs       |     |
| <b>Semiconductor Physics:</b> Classification of solids- Insulator, Semiconductor and Metal using energy band diagram, Semiconductor- Mobility and Conductivity, Classification of semiconductors, Drift and diffusion currents, Charge densities in semiconductors, Fermi-dirac function, Fermi level in intrinsic and extrinsic semiconductor, Hall effect, Continuity equation                                               |            |             |     |
| <b>Semiconductor Diode Characteristics:</b> Theory of PN Junction diode, Quantitative theory of PN                                                                                                                                                                                                                                                                                                                             |            |             |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| diode currents, Diode current equation, V-I characteristics- Temperature dependence of V-I characteristics of diodes, Diode resistance, Diode capacitance, Energy-band diagram of PN Junction diode, Zener diode, Breakdown mechanism, Zener diode applications, Varactor diode, Tunnel diode<br><i>Self-Learning Topics (SLTs): solved problems (Text2: example 1.5, 1.6, 1.13, 2.2, 2.7, 2.13).</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>9 Hrs</b> |
| <p><b>Bipolar Junction Transistors:</b> Bipolar junction transistor, transistor current components, operation of NPN transistor, Operation of PNP transistor, Transistor configuration: common base, common emitter, common collector, transistor as an amplifier, large signal, d.c. and small signal CE values, Ebers-Moll model, breakdown in transistors</p> <p><b>Special Diodes:</b> Light emitting diode (LED) and its applications, Photodetectors- Photo diode, Photo transistor and its applications, P-I-N diode, Avalanche diode; Solar cell- structure, working principle and its I-V characteristics</p> <p><i>Self-Learning Topics (SLTs): solved problems (Text2: 4.11, 4.12, 4.20, 4.21)</i></p>                                                                                                                                                                                                                                                                                                                         |              |
| <b>LABORATORY COMPONENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |              |
| <p style="text-align: center;"><b>List of Experiments</b></p> <ol style="list-style-type: none"> <li>1. Linear Measurements using Vernier callipers and screw gauge</li> <li>2. Determination of slit width using He-Ne laser</li> <li>3. Determination of wavelength of He-Ne laser-using reflection and transmission diffraction grating</li> <li>4. Numerical aperture and acceptance angle of an optical fiber</li> <li>5. Determination of dielectric constant of materials using parallel plate capacitor</li> <li>6. Magnetic hysteresis- B-H curve tracing using CRO</li> <li>7. Study of V-I characteristics of PN junction diode</li> <li>8. Study of V-I characteristics of Zener diode</li> <li>9. Study of common emitter characteristics of NPN transistor</li> <li>10. Study of common base characteristics of NPN transistor</li> <li>11. Energy band gap of a semiconductor material</li> <li>12. Determination of Hall coefficient, carrier density of given semiconducting material using Hall effect setup</li> </ol> |              |
| <p><b><u>TextBook(s):</u></b></p> <ol style="list-style-type: none"> <li>1. M. Avadhanulu and Kshirsagar, TVS Arun Murthy, <i>A Text Book of Engineering Physics</i>, S. Chand &amp; Company Ltd, 11th ed. ISBN- 978-93-528-3399-3, 2018</li> <li>2. S Salivahanan, N Suresh Kumar, <i>Electronic devices and circuits</i>, Mc Graw Hill Education (India) private limited, ISBN-10: 93-392-1225-8, 2015</li> <li>3. K.B.Raina, S.K.Bhattacharya, T. Joneja, <i>Electrical Engineering Materials and Electronic Components</i>, S.K.Kataria &amp; Sons Publisher, ISBN-10: 81-85749-84-1, 2005</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
| <p><b><u>Reference Book(s):</u></b></p> <ol style="list-style-type: none"> <li>1. Bhattacharya and Bhaskaran, <i>Engineering Physics</i>, Oxford University Press, 1st ed. ISBN- 9780198065425, 2013</li> <li>2. V. Rajendran, <i>Engineering Physics</i>, Mc Graw Hill, ISBN-13: 978-9-35-134295-3, 2013</li> <li>3. R.K. Gaur and S.L.Gupta, <i>Engineering Physics</i>, Dhanpath Rai and Sons publications, ISBN-10: 8189928228, 2013</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |

- David Halliday, Robert Resnick & S Krane, *Physics Volume I&II*, Wiley India Limited, 5th ed. ISBN-10: 9788126510887, 2014

#### **Web and Video link(s):**

- [https://onlinecourses.nptel.ac.in/noc24\\_ph28/preview](https://onlinecourses.nptel.ac.in/noc24_ph28/preview); NPTEL video lecture on Concepts in Magnetism and Superconductivity by Prof. Arghya Taraphder IIT Kharagpur
- [https://onlinecourses.nptel.ac.in/noc24\\_lw07/preview](https://onlinecourses.nptel.ac.in/noc24_lw07/preview); NPTEL video lecture on Introduction to Law on Electricity by Prof. Uday Shankar, IIT Kharagpur
- [https://onlinecourses.nptel.ac.in/noc24\\_ph45/preview](https://onlinecourses.nptel.ac.in/noc24_ph45/preview); NPTEL Video Lecture on Introduction to LASER - Course by Prof. M. R. Shenoy, IIT Delhi
- [https://onlinecourses.nptel.ac.in/noc20\\_ee77/preview](https://onlinecourses.nptel.ac.in/noc20_ee77/preview); NPTEL Video Lecture on Semiconductor Devices and Circuits By Prof. Sanjiv Sambandan, IISc Bangalore

#### **Laboratory Manual (for laboratory component):**

- Engineering Physics Laboratory Manual & Record Book, Department of PS, KITSW
- A.K.Katiyar, C.K.Pandey, *Engineering Physics Theory and Practical*, Wiley India Pvt. Ltd, 2nd ed. ISBN- 978-81-265-7015-7, 2017

#### **Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

- CO1:** evaluate properties of lasers and optical fibre parameters
- CO2:** determine the dielectric constant of a material and properties of magnetic & superconducting materials
- CO3:** analyze V-I characteristics of semiconductor diodes and suggest their applications in electronics engineering
- CO4:** Analyze transistor input/output characteristics in CB, CE, CC configuration and analyze I-V characteristics of LED, Photo diode, Solar cell

*(based on psychomotor skills acquired from laboratory component)*

- CO5:** measure diameter of wire and hollow tubes using Vernier calipers and screw gauge
- CO6:** determine the width of a narrow slit and wavelength of laser using diffraction phenomenon and numerical aperture of an optical fiber
- CO7:** determine forward voltage and currents from V-I characteristics of semiconductor diodes
- CO8:** identify cut-off, saturation and active regions of NPN transistor

| Course Articulation Matrix (CAM): |             |      |      |      | U24PY102E ENGINEERING PHYSICS (for ECE) |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|------|------|------|-----------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1 | PO 2 | PO 3 | PO 4                                    | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24PY102E.1 | 2    | 1    | -    | -                                       | -    | 1    | 1    | 1    | 1    | -     | 1     | 1     | 1     |
| CO2                               | U24PY102E.2 | 2    | 1    | -    | -                                       | -    | 1    | 1    | 1    | 1    | -     | 1     | 1     | 1     |
| CO3                               | U24PY102E.3 | 2    | 1    | -    | -                                       | -    | 1    | 1    | 1    | 1    | -     | 1     | 1     | 1     |
| CO4                               | U24PY102E.4 | 2    | 1    | -    | -                                       | -    | 1    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO5                               | U24PY102E.5 | 2    | 1    | -    | -                                       | 1    | 1    | 1    | 1    | 2    | -     | 1     | 1     | 1     |
| CO6                               | U24PY102E.6 | 2    | 1    | -    | -                                       | 1    | 1    | 1    | 1    | 2    | -     | 1     | 1     | 1     |
| CO7                               | U24PY102E.7 | 2    | 1    | -    | -                                       | 1    | 1    | 1    | 1    | 2    | -     | 1     | 1     | 1     |
| CO8                               | U24PY102E.8 | 2    | 1    | -    | -                                       | 1    | 1    | 1    | 1    | 2    | 1     | 1     | 1     | 1     |
| U24PY102E                         |             | 2    | 1    | -    | -                                       | 1    | 1    | 1    | 1    | 1.5  | 1     | 1     | 1     | 1     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |             |      |      |      |                                         |      |      |      |      |      |       |       |       |       |

| SWITCHING THEORY AND LOGIC DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |            |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|-------|
| Class: B.Tech. I -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           | Branch:ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | U24EC103  | Credits:   | 3     |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2-1-0-6-9 | CIE:       | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 36 Hrs.   | ESE:       | 40%   |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> number system and binary codes, minimization of switching functions<br><b>LO2:</b> combinational circuits design and implementation using logic gates, adders/subtractors, multiplexer and decoders<br><b>LO3:</b> implementation of sequential circuits, counters, registers using flip flops and logic gates<br><b>LO4:</b> finite state machines and its minimization                                                                                                                                                                            |           |            |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |            | 9 Hrs |
| <b>Number Systems:</b> Review of number systems, binary weighted and non-weighted codes, binary arithmetic, 1's & 2's complement subtraction, error detecting and correcting codes, Hamming code<br><b>Boolean Algebra:</b> Postulates and theorems, logic gates and truth tables, representation of switching functions using SOP & POS forms, Karnaugh map representation, minimization using K-Map<br><i>Self-Learning Topics (SLTs): Solved problems (Text1: Prob 1.3), Solved problems (Text2: example problems 1.7, 1.18, 1. 25, 1.25, 1. 36, 1.84, 2.8, 2.28,2.38), Don't care conditions (Text1: topic 3.6), Other two-level implementations (Text1: topic 3.8).</i> |           |            |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |            | 9 Hrs |
| <b>Combinational Circuits:</b> Adders- half Adder, full Adder; subtractors-half subtractor, full Subtractor; parallel adder, Carry look ahead adder, Decoders, decoders - BCD to 7 segments, BCD to decimal. Encoders-priority encoder, Multiplexer and Demultiplexer, realization of switching functions using multiplexers and decoders<br><i>Self-Learning Topics (SLTs): decimal adder (Text1: topic 4.6), Priority encoders (Text2: topic 4.22)</i>                                                                                                                                                                                                                     |           |            |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |            | 9 Hrs |
| <b>Sequential Circuits:</b> Flip Flops - SR, JK, Race Around Condition in JK, JK Master Slave, D and T Flip Flops, Excitation Tables, Conversion from one type of Flip-Flop to another. Shift Registers, Bidirectional Shift Registers, Ring counter and Johnson Counter; Design of Asynchronous and Synchronous Counters (modulo-N)<br><i>Self-Learning Topics (SLTs): latches (Text2: topic 6.4.1, 6.4.2), edge triggered Flip-flops (Text2: topic 6.4.3), master slave Flip Flops (Text2: topic 6.9)</i>                                                                                                                                                                  |           |            |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |            | 9 Hrs |
| <b>State minimization:</b> state table, state diagram, state assignment, state minimization, synthesis of synchronous, sequential circuits – sequence detectors<br><b>Finite State Machines:</b> Mealy and Moore machines – capabilities and limitations of finite state machine, state equivalence and machine minimization- Merger graph and Merger table<br><i>Self-Learning Topics (SLTs):capabilities and limitations of finite state machine (Ref Text3:10.2) simplification of incompletely specified machines (Ref Text3:10.4)</i>                                                                                                                                   |           |            |       |

**Course Learning Outcomes (COs):**

After completion of this course, the students should be able to...

- CO1:** explain number system and binary codes; prove the given Boolean identity and apply minimization techniques to obtain minimal SOP/POS forms of logic functions
- CO2:** design switching functions using combinational circuits for given application
- CO3:** develop a sequential circuit using flip-flops and logic gates for given specifications
- CO4:** develop finite state machine with optimum states for given specifications

**TextBook(s):**

1. M. Moris Mano, *Digital Design*, 4th ed. PHI, New Delhi, 2006. (Chapters 1 to 6)
2. A. Anand Kumar, *Switching Theory & Logic Design*, 2nd ed. PHI, 2014 (Chapters 1 to 4, 6, 7)

**Reference Book(s):**

1. G.K. Kharate, *Digital Electronics*, Oxford University Press, Hyderabad, 1<sup>st</sup> edition, 2012
2. R.P. Jain, *Modern Digital Electronics*, Tata McGraw-Hill, India, 4<sup>th</sup> edition, 2010
3. Zvi. Kohavi, *Switching and Finite Automata Theory*, Cambridge University Press, 3<sup>rd</sup> edition, 2010
4. Samuel. C. Lee & B.S. Sonde, *Digital Circuits & Logic Design*, PHI, New delhi, 1<sup>st</sup> edition, 1976

**Web and Video link(s):**

1. <https://www.youtube.com/watch?v=JmJWpX2ECfI> NPTEL Video Lecture on Error Detection and Correction
2. <https://www.youtube.com/watch?v=BPBiyc0OBw> NPTEL Video Lecture on K maps
3. <https://www.youtube.com/watch?v=NHydMByCsZQ&t=638s> NPTEL Video Lecture on logic design
4. <https://www.youtube.com/watch?v=5Zstl5d5Byc> NPTEL Video Lecture on Minimization of Finite State Machines.

| Course Articulation Matrix (CAM) |            |      |      |      | U24EC103 SWITCHING THEORY AND LOGIC DESIGN |      |      |      |      |      |       |       |       |       |
|----------------------------------|------------|------|------|------|--------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                               |            | PO 1 | PO 2 | PO 3 | PO 4                                       | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                              | U24EC103.1 | 3    | 2    | 1    | -                                          | -    | 1    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO2                              | U24EC103.2 | 3    | 2    | 1    | -                                          | -    | 1    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO3                              | U24EC103.3 | 3    | 2    | 2    | 1                                          | -    | 2    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO4                              | U24EC103.4 | 3    | 2    | 3    | 3                                          | -    | 3    | 1    | 1    | 1    | 1     | 1     | 3     | 1     |
| U24EC103                         |            | 3    | 2    | 1.75 | 2                                          | -    | 1.75 | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW    |            |      |      |      |                                            |      |      |      |      |      |       |       |       |       |

# PROGRAMMING FOR PROBLEM SOLVING WITH C

|                                                                                                                                                                                                                                                                                                                                                                            |            |            |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|-----|
| Class: B.Tech. I -Semester                                                                                                                                                                                                                                                                                                                                                 |            | Branch:ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                               | U24EC104   | Credits:   | 4   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                    | 2-1-2-5-10 | CIE:       | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                            | 60 Hrs.    | ESE:       | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                                                          |            |            |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                                                     |            |            |     |
| LO1: algorithms, flow charts and develop programs with basic constructs                                                                                                                                                                                                                                                                                                    |            |            |     |
| LO2: control structures and array operations                                                                                                                                                                                                                                                                                                                               |            |            |     |
| LO3: string operations and modular programming concepts with functions and recursion                                                                                                                                                                                                                                                                                       |            |            |     |
| LO4: structures, unions, pointers and files in C programming                                                                                                                                                                                                                                                                                                               |            |            |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                                                           |            |            |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                     |            | 9 Hrs      |     |
| Introduction to Programming: Art of programming through algorithms and flowcharts                                                                                                                                                                                                                                                                                          |            |            |     |
| Overview of C: History of C, Importance of C, Basic structure of C programs                                                                                                                                                                                                                                                                                                |            |            |     |
| Constants, Variables and Data Types: Character set, C tokens, declaration of variables, defining symbolic constants                                                                                                                                                                                                                                                        |            |            |     |
| Managing Input and Output Operations: Reading a character, writing a character, formatted input, formatted output                                                                                                                                                                                                                                                          |            |            |     |
| Operators and Expressions: Arithmetic, Relational, Increment, Decrement, Conditional, Logical, Bit-wise, Special operators, Arithmetic expressions, Evaluation of expressions, Operator precedence and associativity                                                                                                                                                       |            |            |     |
| Self-Learning Topics (SLTs): Components of a computer, concept of hardware and software (Text1: chapter 1), Executing a C program (Text1: chapter 2), Type conversions in expression (Text1: chapter 4) Solved problems (Text1: chapter 2 to chapter 5), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 2 to chapter 5) |            |            |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                    |            | 9 Hrs      |     |
| Decision Making and Branching: Simple if statement, if-else statement, Nesting of if-else statements, else if ladder, switch statement, Conditional operator, goto statement                                                                                                                                                                                               |            |            |     |
| Decision Making and Looping: while statement, do-while statement, for statement, Nested loops, Jumps in loops                                                                                                                                                                                                                                                              |            |            |     |
| Arrays: One-dimensional arrays, Declaration of one-dimensional arrays, Initialization of one-dimensional arrays, Linear search, Two-dimensional arrays, Initializing two dimensional arrays, multi-dimensional arrays                                                                                                                                                      |            |            |     |
| Self-Learning Topics (SLTs): Concise test expressions (Text1: chapter 7) Dynamic arrays (Text1: chapter 8), Solved problems (Text1: chapter 6 to chapter 8), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 6 to chapter 8)                                                                                             |            |            |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                   |            | 9 Hrs      |     |
| Character Arrays and Strings: Declaring and initializing string variable, reading strings from terminal, Writing strings to screen, String handling functions, Table of strings                                                                                                                                                                                            |            |            |     |
| Modular Programming with User Defined Functions: Need for user-defined functions, Elements of user-defined functions, Definition of functions, Return values and their types,                                                                                                                                                                                              |            |            |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <p>Function calls, Function declaration, Category of functions, Recursion, The scope, visibility and lifetime of variables (storage classes)</p> <p><b>Self-Learning Topics (SLTs):</b> Arithmetic operations on characters, comparison of strings (Text1: chapter 9), Nesting of functions, (Text1: chapter 10), Solved problems (Text1: chapter 9 &amp; chapter 10), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 9 &amp; chapter 10)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>9 Hrs</b> |
| <p><b>Structures and Unions:</b> Defining a structure, Declaring and initializing structure variables, Accessing structure members, Array of structures, Structures within structures, Unions</p> <p><b>Pointers:</b> Understanding pointers, Declaring and initializing pointer variables, Pointer expressions, Pointers and arrays, Pointers and character strings, Pointers to functions, Pointers and structures</p> <p><b>File Management in C:</b> Defining and opening a file, Closing a file, Input and output operations on sequential text files</p> <p><b>Self-Learning Topics (SLTs):</b> Operations on individual members (Text1: chapter 11), Chain of pointers, array of pointers (Text1: chapter 12), Random access to files, Command line arguments (Text1: chapter 13). Solved problems (Text1: chapter 11 to chapter 13), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 11 to chapter 13).</p>                                                                                                                        |              |
| <b>LABORATORY COMPONENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |
| <ol style="list-style-type: none"> <li>1. Programs using input output functions, operators (arithmetic, relational and conditional)</li> <li>2. Programs using operators (bit-wise, logical, increment and decrement)</li> <li>3. Programs using conditional control structures: if, if-else, nested if</li> <li>4. Programs using else if ladder, switch and goto statements</li> <li>5. Programs using loop control structures: while</li> <li>6. Programs using loop control structures: do-while and for</li> <li>7. Programs on one dimensional array and two-dimensional arrays</li> <li>8. Programs on String operations and string handling functions</li> <li>9. Programs on different types of functions, parameter passing using call-by-value &amp; call-by-address, recursion and storage classes</li> <li>10. Programs using structures, unions, pointers to arrays and pointers to strings</li> <li>11. Programs using array of pointers and pointers to structures</li> <li>12. Programs on File operations and file handling functions for sequential text files</li> </ol> |              |
| <b><u>TextBook(s):</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |
| 1. E. Balagurusamy, <i>Programming in ANSI C</i> , 8th ed. McGraw Hill, 2022                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
| <b><u>Reference Book(s):</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| <ol style="list-style-type: none"> <li>1. Paul Deitel, Harvey Deitel, <i>C How to Program: With Case Studies Introducing Applications Programming and Systems Programming</i>, Pearson Education Limited, 9th ed. 2022</li> <li>2. Brian W. Kernighan and Dennis Ritchie, <i>The C Programming Language</i>, Pearson Education India, 2nd ed. 2015</li> <li>3. Reema Thareja, <i>Programming in C</i>, Oxford University Press, 3rd ed. 2023</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |

4. Yashavant Kanetkar, *Let Us C*, BPB Publications, 19th ed. 2022
5. A. K. Sharma, *Computer Fundamentals and Programming in C*, Universities Press, 2nd ed. 2018

**Web and Video link(s):**

1. <https://nptel.ac.in/courses/106105171> NPTEL Video Lecture on Problem Solving through Programming in C by Prof. Anupam Basu, Professor of CSE, IIT Kharagpur.
2. <https://nptel.ac.in/courses/106104128> NPTEL Video Lecture on Introduction to Programming in C by Prof. Satyadev Nandakumar, Professor of CSE, IIT Kanpur

**Laboratory Manual (for laboratory component):**

1. *Programming for Problem Solving with C Laboratory Manual and Record Book*, Department of ECE, KITSW.

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

**CO1:** enumerate programming development steps, design an algorithm and draw a flow chart for a given application

**CO2:** apply logical skills for problem solving using control structures and arrays

**CO3:** develop string operations and modular programming with functions

**CO4:** analyse and implement structures, unions, pointers and files in C programming

*(based on psychomotor skills acquired from laboratory component)*

**CO5:** develop programs using operators and decision-making statements

**CO6:** apply loops and arrays to develop a program of an application

**CO7:** implement string operations and develop modular programs using user-defined functions, recursion, and storage classes

**CO8:** develop programs using structures, unions, pointers and files

| Course Articulation Matrix (CAM): |            |      |      |      | U24EC104: PROGRAMMING FOR PROBLEM SOLVING WITH C |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|--------------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                                             | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC104.1 | 2    | 1    | 1    | 1                                                | -    | -    | 1    | 1    | 1    | 1     | 2     | 1     | 2     |
| CO2                               | U24EC104.2 | 2    | 2    | 2    | 1                                                | -    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO3                               | U24EC104.3 | 2    | 2    | 3    | 1                                                | -    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO4                               | U24EC104.4 | 2    | 2    | 3    | 2                                                | -    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO5                               | U24EC104.5 | 1    | 1    | 1    | 1                                                | 1    | -    | 1    | 1    | 1    | 1     | 2     | 1     | 2     |
| CO6                               | U24EC104.6 | 1    | 2    | 2    | 2                                                | 1    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO7                               | U24EC104.7 | 1    | 2    | 3    | 2                                                | 1    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO8                               | U24EC104.8 | 1    | 2    | 3    | 2                                                | 1    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| U24EC104                          |            | 1.5  | 1.75 | 2.25 | 1.5                                              | 1    | -    | 1    | 1    | 1    | 1     | 2     | 1.75  | 2     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |            |      |      |      |                                                  |      |      |      |      |      |       |       |       |       |

| BASIC ELECTRICAL ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                       |            |                              |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------------|------|
| Class: B.Tech. I -Semester                                                                                                                                                                                                                                                                                                                                                                                                         |            | Branch: Common to ECE & ECIE |      |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                       | U24EE105B  | Credits:                     | 4    |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                            | 2-1-2-5-10 | CIE:                         | 60 % |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                    | 60 Hrs.    | ESE:                         | 40 % |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                                                                                                                  |            |                              |      |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                                                                                                             |            |                              |      |
| LO1: network elements and DC circuits                                                                                                                                                                                                                                                                                                                                                                                              |            |                              |      |
| LO2: DC network theorems                                                                                                                                                                                                                                                                                                                                                                                                           |            |                              |      |
| LO3: 1- Ø AC circuits, 3-Ø AC circuits, and series resonance                                                                                                                                                                                                                                                                                                                                                                       |            |                              |      |
| LO4:construction, principles, and applications of DC & AC machines, concepts of earthing, fuses, and MCB                                                                                                                                                                                                                                                                                                                           |            |                              |      |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                                                                                                                   |            |                              |      |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                             |            | 9 Hrs                        |      |
| DC circuits: Network elements, Linear &non-linear elements, Active & passive elements, Unilateral & bilateral elements, Ohm's law, Power, Energy, Kirchhoff's laws, Resistances connected in series and parallel, Voltage divider rule & Current divider rule                                                                                                                                                                      |            |                              |      |
| DC circuit analysis:Source transformation, Star-Delta conversion, Mesh analysis & Nodal analysis. (T & $\pi$ networks only)                                                                                                                                                                                                                                                                                                        |            |                              |      |
| Self-Learning Topics (SLTs): Definitions of charge, current, & voltage (Text1: Topics1.2), Solved problems (Text1: Prob 3.10,3.11&3.12), Practice problems (Text1: Chap-3, Prob 4,5,7&8)                                                                                                                                                                                                                                           |            |                              |      |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                            |            | 9 Hrs                        |      |
| DC network theorems (Independent sources only): Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem&Reciprocity theorem. (T and $\pi$ networks only)                                                                                                                                                                                                                                       |            |                              |      |
| Self-Learning Topics (SLTs): Condition for maximum power transfer(Text1: Topics3.9), Solved problems (Text1: Prob 3.15,3.18,3.23&3.25), Practice problems (Text1: Chap-3, Prob9,10,13&14)                                                                                                                                                                                                                                          |            |                              |      |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                           |            | 9 Hrs                        |      |
| 1-Ø AC circuits: R.M.S value, Average value, Peak factor and form factor of a sine wave, Concept of phasor, Phase and Phase difference, Rectangular and Polar form representation, Sinusoidal steady state analysis of R, L, C, Series RL, RC, RLC circuits, Parallel RL, RC & RLC circuits, Concept of reactance, Impedance, Susceptance, Admittance, Complex power, Real power, Reactive power and Power factor&Series Resonance |            |                              |      |
| 3- Ø AC circuits: Generation of 3- Ø voltages, Advantages, Disadvantages, Applications of a three-phase system, Voltage & Current relationships of line and phase values for balanced star and delta connections                                                                                                                                                                                                                   |            |                              |      |
| Self-Learning Topics (SLTs): Expression for RMS & Average value (Text1: Topic,4.4&4.5) Solved problems (Text1: Prob4.10,4.12,4.13& 4.14), Practice problems (Text1: Chap-4, Prob 8,9,12&12)                                                                                                                                                                                                                                        |            |                              |      |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                            |            | 9 Hrs                        |      |
| Electrical machines & Electrical Earthing (Qualitative treatment):                                                                                                                                                                                                                                                                                                                                                                 |            |                              |      |
| Electrical Machines: Construction, Principle of operation, Characteristics &applications of 1- Ø transformer, 1- Ø induction motor, DC motor, Stepper motor and BLDC motor                                                                                                                                                                                                                                                         |            |                              |      |
| Electrical earthing, Fuses: Basic concepts of electric shock, Earthing, Fuses, Miniature Circuit Breaker (MCB)                                                                                                                                                                                                                                                                                                                     |            |                              |      |
| Self-Learning Topics (SLTs): EMF equation of a Transformer (Text1: Part-II Topic,4.4.2) Solved                                                                                                                                                                                                                                                                                                                                     |            |                              |      |

problems (Text1: Part-II Prob 4.5, 4.6 & 4.7), Practice problems (Text1: Part-II Prob 5.2, 5.3 & 5.4), Practice problems (Text1: Part-II Prob 6, 7 & 8)

## LABORATORY COMPONENT

### List of Experiments

1. Verification of voltage divider rule and current divider rule
2. Verification of Mesh Analysis
3. Verification of Nodal Analysis
4. Verification of Superposition Theorem
5. Verification of Thevenin's Theorem
6. Verification of Maximum power transfer Theorem
7. Determination of internal parameters of a choke coil
8. Impedance calculations and phasor representation of RL series circuit
9. Impedance calculations and phasor representation of RC series circuit
10. Load test on 1-phase transformer
11. Verification of Kirchoff's laws using PSPICE/MATLAB
12. Interfacing Sensors with Arduino using TINKER CAD
  - i. LED blinking
  - ii. IR Sensor
  - iii. Ultrasonic Sensor
  - iv. Voltage Sensor
  - v. Current Sensor
  - vi. Speed Sensor

#### **TextBook(s):**

1. K. Uma Rao, *Basic Electrical Engineering*, Pearson Education, 2011

#### **Reference Book(s):**

1. B.L. Thereja, A.K. Thereja, *Electrical Technology Vol. I & II*, S. Chand & Company Ltd, 2005
2. Edward Hughes, *Electrical & Electronics Technology*, Pearson Education, 10th ed. 2010
3. D. P. Kothari and I. J. Nagrath, *Basic Electrical Engineering*, Tata McGraw Hill Edition, 2010.
4. Chakravarthy A, Sudhipanath and Chandan Kumar, *Basic Electrical Engineering*, Tata McGraw Hill Ltd, 4th ed. 2013

#### **Web and Video link(s):**

1. <https://nptel.ac.in/courses/108/105/108105112/>; NPTEL Video Lecture on Fundamentals of Electrical Engineering by Prof. Debapriya Das, Professor of EED, IITK Kharagpur.

#### **Laboratory Manual (for laboratory component):**

1. *Basic Electrical Engineering Laboratory Manual and Record Book*, Department of EEE, KITSW

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to,*

*(based on cognitive skills acquired from the theory component)*

**CO1:** determine voltage, current & power in electrical circuits using network reduction techniques, mesh & nodal analysis

**CO2:** apply suitable network theorems to analyze DC circuits

**CO3:** determine impedance, voltage, current, power in 1- Ø & 3- Ø AC circuits and bandwidth & quality factor of series resonant circuit

**CO4:** select a suitable electrical machine for a given application and analyze the essential roles of electrical earthing, fuses, and MCBs in electrical systems

*(based on psychomotor skills acquired from laboratory component)*

**CO5:** validate mesh and nodal analysis

**CO6:** validate network theorems

**CO7:** determine the impedance of series RL & RC circuits at various operating frequencies

**CO8:** determine the efficiency of a transformer using load test and verify Kirchhoff's laws using PSPICE

| Course Articulation Matrix (CAM): |             |      | U24EE105B BASIC ELECTRICAL ENGINEERING |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|------|----------------------------------------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1 | PO 2                                   | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EE105B.1 | 2    | 1                                      | -    | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO2                               | U24EE105B.2 | 2    | 2                                      | -    | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO3                               | U24EE105B.3 | 3    | 3                                      | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO4                               | U24EE105B.4 | 3    | 3                                      | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO5                               | U24EE105B.5 | 2    | 1                                      | -    | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO6                               | U24EE105B.6 | 2    | 2                                      | -    | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO7                               | U24EE105B.7 | 3    | 3                                      | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO8                               | U24EE105B.8 | 3    | 3                                      | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| U24EE105B                         |             | 2.5  | 2.25                                   | 1    | 1    | 1    | 1    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |                                        |      |      |      |      |      |      |      |       |       |       |       |

| ENVIRONMENTAL STUDIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                                           |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------------------------------|------|
| Class:B.Tech.I Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           | Branch:Common to CE, EEE, ECIE, ECE & CSE |      |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | U24CY106  | Credits:                                  | 0    |
| Hours/Week(L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2-0-0-3-5 | CIE:                                      | 60%  |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 24Hrs.    | ESE:                                      | 40%  |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in/on...</i><br><b>LO1:</b> natural resources and their usage more equitably<br><b>LO2:</b> ecosystem and the importance of biodiversity conservation<br><b>LO3:</b> environmental pollution and its control measures<br><b>LO4:</b> environmental legislation and green methodology                                                                                                                                                                                                                                                                                                                                                                          |           |                                           |      |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                                           | 6Hrs |
| <b>The Multidisciplinary Nature of Environmental Studies:</b> Definition, Scope and importance<br><b>Natural Resources:</b> Forest Resources-Use and over exploitation of forests, Deforestation, Timber extraction, Mining, Dams and their effects on forests and tribal people; Water Resources-Use and over-utilization of surface and ground water, Floods, Drought, Conflicts over water; Mineral Resources-Environmental effects of extracting and using mineral resources; Energy Resources-Renewable and non-renewable energy sources, Use of alternate energy sources<br><b>Self-Learning Topics (SLTs):</b> Use and over-utilization of surface and ground water (Text1: unit 2, topic: 2.2.2) world food problems (Text1: unit 2, topic 2.2.2) |           |                                           |      |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                           | 6Hrs |
| <b>Ecosystem and Biodiversity:</b><br><b>Ecosystem:</b> Concepts of an ecosystem, Food chain, Food webs, Ecological pyramids, Energy flow in the ecosystem and ecological succession<br><b>Biodiversity and its Conservation:</b> Introduction, Definition, Genetic, Species and ecosystem diversity, Value of biodiversity, Biodiversity in India, Hot spots of biodiversity, Man-wildlife conflicts, Endangered and endemic species of India; In-situ and Ex-situ conservation<br><b>Self-Learning Topics (SLTs):</b> Introduction and definition of biodiversity (Text1: unit 4, topic 4.1)                                                                                                                                                            |           |                                           |      |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                                           | 6Hrs |
| <b>Environmental Pollution:</b> Global Issues-Global climatic change, Greenhouse gases, Effects of global warming, Ozone layer depletion<br><b>International Conventions/Protocols:</b> Earth summit, Kyoto protocol, Montreal protocol<br><b>Environmental Pollution-</b> Causes and effects of air, Water, Soil, Marine and noise pollution with case studies<br><b>Solid and Hazardous Waste Management:</b> Introduction, Types, Effects of urban industrial and nuclear waste<br><b>Natural Disaster Management:</b> Introduction to disaster, Management of disaster, Disaster management of flood, earthquake, cyclone and landslides                                                                                                              |           |                                           |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Role of information technology in environment and human health<br><i>Self-Learning Topics (SLTs): Role of individual in prevention of pollution (Text1: unit 5, topic 5.10)</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>6Hrs</b> |
| <p><b>Social Issues and the Environment:</b> Role of Individual and Society, Water conservation, Rain water harvesting</p> <p><b>Environmental Protection/Control Acts:</b> Air (prevention and control of pollution) act 1981, Forest conservation act (1980 and 1992), Wildlife protection act 1972, Environment protection act 1986, Issues involved in enforcement of environmental legislations</p> <p><b>Green Methodology:</b> Principles of green chemistry, green methods in electronic production, Impact of electronic waste on public health and environment; United nations goals of sustainable development</p> <p><i>Self-Learning Topics (SLTs): Water (prevention and control of pollution) act 1974 (Text1: unit 6, topics 6.10), Water pollution cess act 1977 (Text1: unit 6, topics 6.11)</i></p> |             |
| <p><b>Course Learning Outcomes (COs):</b></p> <p><i>After completion of this course, the students should be able to,</i></p> <p><b>CO1:</b> identify the natural resources and practice their usage more equitably</p> <p><b>CO2:</b> develop an action plan for sustainable alternatives and conserving biodiversity</p> <p><b>CO3:</b> examine and perceive the solutions for the environmental pollution</p> <p><b>CO4:</b> adapt issues involved in enforcement of environmental legislation and green methodology</p>                                                                                                                                                                                                                                                                                             |             |
| <p><b><u>Text Book(s):</u></b></p> <p>1. Erach Bharucha, <i>Text Book of Environmental Studies for Under Graduate Courses</i>, 2nd ed. Universities Press (India) Pvt. Ltd, 2013</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |
| <p><b><u>Reference Book(s):</u></b></p> <ol style="list-style-type: none"> <li>1. Y. Anjaneyulu, <i>Introduction to Environmental Science</i>, B.S. Publications, 2004</li> <li>2. Gilbert M. Masters, <i>Introduction to Environmental Engineering &amp; Science</i>, 3rd ed. Prentice Hall of India, 1991</li> <li>3. Anubha Kaushik, C.P. Kaushik, <i>Environmental Studies</i>, 4th Edition, New Age International Publishers, 2014</li> <li>4. R. Rajagopalan, <i>Environmental Studies from crisis to cure</i>, Oxford University Press, 2nd ed. 2011</li> </ol>                                                                                                                                                                                                                                                 |             |
| <p><b><u>Web and Video link(s):</u></b></p> <ol style="list-style-type: none"> <li>1. <a href="https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/videolectureon%20renewable%20energy%20resources%20by%20Prof.%20Vaibhav.%20V.%20Goud%20and%20Dr.%20R.%20Anandalakshmi%20Dept.%20Of%20Chemical%20Engineering%20Guwahati">https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/videolectureon renewable energy resources by Prof. Vaibhav. V. Goud and Dr. R. Anandalakshmi, Dept. Of Chemical Engineering, Guwahati</a></li> </ol>                                                                                                                                                                                                                                                                 |             |

| Course Articulation Matrix (CAM): |            | U24CY106 ENVIRONMENTAL STUDIES |      |      |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|--------------------------------|------|------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1                            | PO2  | PO3  | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24CY106.1 | 2                              | 1    | 2    | 1   | -   | 2   | 1   | 1   | 1   | 1    | 1    | 1    | 1    |
| CO2                               | U24CY106.2 | -                              | -    | 2    | 1   | -   | 1   | 1   | 1   | 1   | 1    | 1    | 1    | 1    |
| CO3                               | U24CY106.3 | 1                              | 2    | 1    | 1   | -   | 1   | 1   | 1   | 1   | 1    | 1    | 1    | 1    |
| CO4                               | U24CY106.4 | -                              | -    | 1    | 1   | -   | 2   | 1   | 1   | 1   | 1    | 1    | 1    | 1    |
| U24CY106                          |            | 0.75                           | 0.75 | 1.50 | 1   | -   | 1.5 | 1   | 1   | 1   | 1    | 1    | 1    | 1    |
| 3-HIGH, 2-MEDIUM, 1-LOW           |            |                                |      |      |     |     |     |     |     |     |      |      |      |      |

## IDEA LAB MAKERSPACE

|                                   |                  |                                       |             |
|-----------------------------------|------------------|---------------------------------------|-------------|
| <b>Class:</b> B.Tech.I Semester   |                  | <b>Branch:</b> Common to all branches |             |
| <b>Course Code:</b>               | <b>U24AE107</b>  | <b>Credits:</b>                       | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>    | <b>0-0-2-2-4</b> | <b>CIE:</b>                           | <b>100%</b> |
| <b>Total Number of Lab Hours:</b> | <b>36 Hrs.</b>   | <b>ESE:</b>                           | <b>-</b>    |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

**LO1:** carpentry and CNC wood router

**LO2:** mould for sand casting and arc welding joints

**LO3:** laser engraving, 3D printing and robots in manufacturing

**LO4:** Printed Circuit Board (PCB) and Internet of Things (IoT)

### LABORATORY COMPONENT

| LABORATORY COMPONENT |                                 |                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| S. No.               | Creative Fabrication Technology | List of Experiments                                                                                                                                                                                                                                                                                                                                                                       |
| 1.                   | Carpentry                       | Prepare a half lap dovetail joint                                                                                                                                                                                                                                                                                                                                                         |
| 2.                   | CNC Wood Router                 | Perform wood carving using CNC Wood Router                                                                                                                                                                                                                                                                                                                                                |
| 3.                   | Foundry                         | Prepare a sand mould using single piece pattern                                                                                                                                                                                                                                                                                                                                           |
| 4.                   | Welding                         | Prepare a single V-butt joint on mild steel plates using AC arc welding machine                                                                                                                                                                                                                                                                                                           |
| 5.                   | Injection Moulding              | Prepare a plastic product using Injection moulding machine                                                                                                                                                                                                                                                                                                                                |
| 6.                   | Laser Engraving                 | Perform key chain by using CO <sub>2</sub> laser cutting machine                                                                                                                                                                                                                                                                                                                          |
| 7.                   | 3D Printing                     | Prepare a key chain on 3D printer with the given dimensions                                                                                                                                                                                                                                                                                                                               |
| 8.                   |                                 | Prepare a Spur Gear on 3D printer with the given dimensions                                                                                                                                                                                                                                                                                                                               |
| 9.                   | Robotics                        | Perform basic pick-and-place operation using robot                                                                                                                                                                                                                                                                                                                                        |
| 10.                  | Printed Circuit Board (PCB)     | Design and fabricate a PCB for a given application                                                                                                                                                                                                                                                                                                                                        |
| 11.                  | Internet of Things (IoT)        | Measure the temperature and humidity by using DHT11 sensor and Arduino UNO                                                                                                                                                                                                                                                                                                                |
| 12.                  |                                 | Create a smart plant watering system using IoT                                                                                                                                                                                                                                                                                                                                            |
| Course Project       |                                 | <ul style="list-style-type: none"><li>• Students are required to create an affordable prototype as their course project, based on the knowledge and skills acquired during the course.</li><li>• Students have to present and submit their prototypes to demonstrate their ability to apply classroom learning practically, showcasing their creativity and technical aptitude.</li></ul> |

### Laboratory Manual:

- IDEA Lab Makerspace Laboratory Manual & Record Book (LMRB) prepared by the faculty of department of Mechanical Engineering, KITSW, Revised version 4, August-2024*

**Text/ Reference Book(s):**

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy., *Elements of Workshop Technology*, Media Promoters and publishers Pvt. Ltd, India, Vol-I-2008 & Vol-II-2010.
2. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani, *Additive Manufacturing Technologies- 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*, Springer Nature, 2nded. 2021
3. R.S. Khandpur, *Printed Circuit Boards: Design, Fabrication, Assembly and Testing*, New Delhi Tata Mc Graw Hill-2008.
4. Sudeep Mishra, Anandarupmukherjee and Arijit Roy, *Introduction to IoT*, New Delhi: University Cambridge Press, 2021.

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to ...*

*(based on psychomotor skills acquired from laboratory component)*

**CO1:** produce wooden joints and intricate articles using carpentry and CNC wood router respectively

**CO2:** implement procedures to prepare the mould cavity for sand casting and arc welding joints

**CO3:** produce innovative prototypes using laser engraving and 3D printing

**CO4:** design and develop systems based on PCB and IoT for given applications

| Course Articulation Matrix (CAM): |            |      |      | U24AE107 IDEA LAB MAKERSPACE |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                         | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24AE107.1 | 2    | 2    | 1                            | 1    | 2    | 1    | 1    | 2    | 2    | -     | 1     | 1     | 1     |
| CO2                               | U24AE107.2 | 2    | 2    | 1                            | 1    | 2    | 1    | 1    | 2    | 2    | -     | 1     | 1     | 1     |
| CO3                               | U24AE107.3 | 2    | 2    | 1                            | 1    | 2    | 1    | 1    | 2    | 2    | -     | 1     | 1     | 1     |
| CO4                               | U24AE107.4 | 2    | 2    | 1                            | 1    | 2    | 1    | 1    | 2    | 2    | -     | 1     | 1     | 1     |
| U24AE107                          |            | 2    | 2    | 1                            | 1    | 2    | 1    | 1    | 2    | 2    | -     | 1     | 1     | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                              |      |      |      |      |      |      |       |       |       |       |

## PRACTICUM - 1

|                                        |                                       |                 |             |
|----------------------------------------|---------------------------------------|-----------------|-------------|
| <b>Class:</b> B.Tech. I semester       | <b>Branch:</b> Common to all branches |                 |             |
| <b>Course Code:</b>                    | <b>U24EL108</b>                       | <b>Credits:</b> | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>0-0-0-4-4</b>                      | <b>CIE:</b>     | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>-</b>                              | <b>ESE:</b>     | <b>-</b>    |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

**LO1:** literature review and identifying research gaps

**LO2:** implementing a project independently by applying knowledge to practice

**LO3:** preparing well-documented report and informative PPT

**LO4:** effective technical presentation and creating video pitch

Practicum is an independent project carried out by the student during the course period, under the supervision of allotted course faculty. It helps to reinforce the students' theoretical knowledge and develop their ability to apply this knowledge to the solution of practical problems. Practicums also prepare them for their MINI and MAJOR PROJECTs and for independent work in their chosen field that promotes creative abilities. Besides they provide Higher Order Cognitive Abilities (HOCAs).

- (i). Practicum is a mandatory semester project work.
- (ii). Practicum is offered as a one credit course. Student has to earn 4 credits (one in each semester from I to IV semesters)
- (iii). Allotment of Practicum topics for students:
  - **Practicum matrix:** In week (-1), the class teacher, in consultation with HoD, shall prepare the practicum matrix of the section. The practicum matrix is the allotment of group of students to the different course faculty of the section, as shown below.

| Course                                 | U24MH101 | J24PY102E | U24EC103 | U24EC104 | J24EE105B | U24CY106 |
|----------------------------------------|----------|-----------|----------|----------|-----------|----------|
| Students allotted to different courses | B24XX001 | B24XX011  | B24XX021 | B24XX031 | B24XX041  | B24XX051 |
|                                        | B24XX002 | B24XX012  | B24XX022 | B24XX032 | B24XX042  | B24XX052 |
|                                        | B24XX003 | B24XX013  | B24XX023 | B24XX033 | B24XX043  | B24XX053 |
|                                        | B24XX004 | B24XX014  | B24XX024 | B24XX034 | B24XX044  | B24XX054 |
|                                        | B24XX005 | B24XX015  | B24XX025 | B24XX035 | B24XX045  | B24XX055 |
|                                        | B24XX006 | B24XX016  | B24XX026 | B24XX036 | B24XX046  | B24XX056 |
|                                        | B24XX007 | B24XX017  | B24XX027 | B24XX037 | B24XX047  | B24XX057 |
|                                        | B24XX008 | B24XX018  | B24XX028 | B24XX038 | B24XX048  | B24XX058 |
|                                        | B24XX009 | B24XX019  | B24XX029 | B24XX039 | B24XX049  | B24XX059 |
|                                        | B24XX010 | B24XX020  | B24XX030 | B24XX040 | B24XX050  | B24XX060 |

- In week (-1), the class teacher of a section shall collect 10-12 topics for practicum from each of the course teachers of that section.
- The class teacher, in consultation with HoD shall allot the practicum topics to the students of that section in the following format.

\*\*\*\*

### **CIRCULAR**

*Allotment of Practicum topics to students*

*Section : .....*

| No. | Roll number of the student | Practicum topic allotted | Practicum under the course | Course faculty |
|-----|----------------------------|--------------------------|----------------------------|----------------|
|     |                            |                          |                            |                |
|     |                            |                          |                            |                |
|     |                            |                          |                            |                |
|     |                            |                          |                            |                |

Note:

1. The students should meet immediately the allotted course faculty for practicum and start working on the practicum with the guidance of course faculty.
2. To complete the Practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and also outside the class work hours during weekdays.
3. The course faculty are advised to guide the allotted students for practicum during the semester course work.

*(Signature of class teacher)*

\*\*\*\*

- To complete the practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and outside the class work hours during weekdays.*
- There shall be only continuous Internal Evaluation (CIE) for practicum for a maximum of 100 marks.
- The practicum course faculty shall evaluate & submit the final marks of the allotted students in week (N+1) to the respective class teacher.
- The class teacher shall collect the final marks of practicum of the students allotted to each course teacher and submit them to the CoE.
- Course faculty shall follow his/her own rubrics for practicum evaluation. Focus shall be on knowledge, skills & qualities acquired by the student during the practicum course
- A sample rubric for assessment and evaluation of practicum is as follows:

|                                                               |                  |
|---------------------------------------------------------------|------------------|
| Literature survey & Identification of research gaps           | 10 marks         |
| Working model / process / software package / system developed | 30 marks         |
| Report writing (subjected to max of 30% plagiarism)           | 20 marks         |
| Oral presentation with PPT and viva-voce                      | 20 marks         |
| Video pitch                                                   | 20 marks         |
| <b>Total</b>                                                  | <b>100 marks</b> |

**Note:** It is mandatory for the student to appear for oral presentation and viva-voce to qualify for course evaluation of Practicum.

- (a) **Practicum Topic:** Each student shall be allotted a topic for practicum by the course faculty member attached to him/her. Interested students can work on their own title for practicum, but with due approval from course faculty.
- (b) **Working Model:** Each student is required to develop a prototype / process / system/simulation model on the given practicum topic and demonstrate/present, during the allotted time, before the course teacher.
- (c) **Report:** Each student is required to submit a well-documented report on the allotted practicum topic as per the format specified by the course faculty. The student shall include answers to the following questions in the report and ppt presentation.
  - What was the objective of the practicum assigned?
  - What are the main responsibilities and tasks for practicum?
  - What knowledge and skills from the coursework are applied in the practicum?
  - What new knowledge and skills are acquired during the practicum?
  - In what ways, can the practicum be helpful for the professional career?
  - What gaps are identified in your practicum work?
  - What improvements or changes you suggest for addressing the identified gaps for future work?
- (d) **Anti-Plagiarism Check:** The practicum report should clear plagiarism check as per the Anti-Plagiarism policy of the institute
- (e) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the course teacher as per the schedule notified by the department
- (f) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her Practicum. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include evidence like videos & pics at the time of implementing the practicum and also key points about his / her business idea / plan (*if any*) and social impact
- (g) The student has to register for the Practicum as a supplementary examination in the following cases:
  - i) he/she is absent for oral presentation and viva-voce
  - ii) he/she fails to submit the report in prescribed format
  - iii) he/she fails to fulfill the requirements of Practicum evaluation as per specified guidelines

**Course Learning Outcomes (COs):**

After completion of this course, the students should be able to...

**CO1:** synthesize literature survey, identify research gaps and define objective & scope of practicum problem

**CO2:** apply knowledge to design & conduct experiments, utilize modern tools for solution of practicum problem and develop working model/ process/ system

**CO3:** demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through practicum

**CO4:** create a video pitch on practicum and make an effective oral presentation using PPTs

| Course Articulation Matrix (CAM): |            |      |      | U24EL108 PRACTICUM-1 |      |      |      |      |      |      |       |       |      |       |
|-----------------------------------|------------|------|------|----------------------|------|------|------|------|------|------|-------|-------|------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO1 | PSO 2 |
| CO1                               | U24EL108.1 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2    | 2     |
| CO2                               | U24EL108.2 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2    | 2     |
| CO3                               | U24EL108.3 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2    | 2     |
| CO4                               | U24EL108.4 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2    | 2     |
| U24EL108                          |            | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2    | 2     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                      |      |      |      |      |      |      |       |       |      |       |

## SOCIAL EMPOWERMENT ACTIVITY/ SELF ACCOMPLISHMENT

| ACTIVITY(SEA/SAA)- 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                |          |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------|------|
| Class: B.Tech. I semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Branch: Common to all branches |          |      |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | U24VA109XXXXX                  | Credits: | 1    |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 0-0-0-2-2                      | CIE:     | 100% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -                              | ESE:     | -    |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in/on...</i><br><b>LO1: holistic development</b> through activity-based learning to gain real-life experience which effectively help individuals deal appropriately with problems/challenges<br><b>LO2: positive mindset</b> by actively adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity and handling rejection in life<br><b>LO3: skills for effective fieldwork practice</b> , which include ethics, observation, communication, interviewing, problem solving, time management, organisation and documentation<br><b>LO4: making a well-documented report and an effective oral presentation</b> through PPTs portraying knowledge, skills, qualities acquired and social impact of the activity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                |          |      |
| <p>Activity Based Liberal Learning about Life, Literature and Culture (ABLL@LLC) is introduced for building <b>generic competencies</b> in students. ABLL is aimed at all dimensional holistic growth of the learner. The holistic development includes the <b>physical, emotional, cognitive, spiritual and social aspects</b>. This is an area which opens the decision-making process, helps the student to develop creativity, an analytical mind, and builds resilience, confidence, hope, well-being and success. This will help student face the world with a greater degree of maturity, stoic and become a wholesome person in the society.</p> <p>It is more than just learning from books to lead a successful life. These activity-based liberal learning courses, which help students to expand their social roles later in life, are offered under two sequels namely <b>SEA</b> (Social Empowerment Activities) and <b>SAA</b> (Self Accomplishment Activities)</p> <p>These SEA/SAA courses also focus on building positive mindset: adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity in your life will help student develop and maintain a positive mindset.</p> <ol style="list-style-type: none"> <li>Each SEA/SAA activity is treated as one credit course</li> <li>Student must select one activity per semester, through first 04 semesters, from the courses listed under SEA/ SAA, before commencement of the semester.</li> <li>Students are required to earn minimum 04 credits under SEA/SAA, by completing minimum 02 credits through SEA and minimum 02 credits through SAA</li> <li>To complete these activities student shall work outside the class work hours, during weekends, holidays, semester breaks, etc.,</li> </ol> |                                |          |      |

- (e) If a student is not able to attend/ fulfil performance requirements, he/she shall be dropped from the course and shall have to enroll in the forthcoming semesters.

**Monitoring SEA/SAA:**

- (a) **Nodal units:** The Student Activity Centre (SAC) and Centre for Innovation Incubation Research and Entrepreneurship (C-i<sup>2</sup>RE) shall act as nodal units for activities listed under SEA/SAA.
- (b) During the semester period, the student has to **acquire requisite knowledge, conduct fieldwork**, acquire skills and propose unique solutions to the real-life problems
- (c) **Knowledge Acquisition & Skilling:**
- Students have to identify goals, acquire and accumulate knowledge on the chosen SEA/SAA activity
  - For the activities related to social awareness/issues/challenges that affect society, use the knowledge base, apply relevant skills to analyse the issue and propose unique possible solutions to the social issues/challenges. Practice to acquire necessary skills to seek new opportunities in their personal and professional life.
  - For the activities related to physical fitness, music, dance, fine arts, etc., guided practice sessions under supervision of expert/guru are to be planned and executed to acquire the benchmark skills to be demonstrated.
- (d) **Fieldwork:** Fieldwork is an essential component of learning for gaining real-life experiences. In addition to knowledge acquisition & skilling, student has to take up fieldwork on the chosen activity, as part of SEA/SAA course.
- This student-driven Fieldwork allows students to interact with the 'real world'. It is an autonomous learning (self-learning) situation that students are more actively involved during the activity and develop a deeper understanding and develop a more positive attitude.
  - Fieldwork consists of three phases: preparation, the actual activity and feedback
  - As part of fieldwork, student has to interact with at least two eminent personalities/achievers/renowned persons/inspiring and great personalities related to the activity chosen.**
  - Fieldwork will benefit students for any careers where they need to work with communities of people or which involves analysis of complex processes, especially social and cultural.
  - Certain skills are required for effective fieldwork, which include observation, communication, interviewing, problem solving, documentation, and more
  - Other skills important for fieldwork practice include the ability to act in a crisis, to plan, set priorities, mobilize resources, and implement the plan effectively. These skills used in an integrated manner help students solve their problems and to develop one's own leadership style based on the need and

culture of the place.

- vii. **Eminent personalities/achievers/renowned persons/inspiring and great personalities**

Eminent personalities/ Achievers / Renowned personalities:

(a). **In case of socially relevant problems/ activities of SEA/SAA:** Eminent personalities/ achievers include district administrative officers, Eminent Social workers / NGOs, other inspiring and great personalities

(b). **In case of Sports / Games and Cultural activities of SEA/SAA:** Eminent coaches/ trainers/ gurus, achievers who represented/ won state level/ national level / international level competitions, other inspiring and great personalities.

- viii. **For appointment to interact eminent personalities:** Student is expected to follow email etiquette rules and other appropriate polite communication etiquettes for getting appointment and time for interaction
- ix. On fieldwork, student is expected to demonstrate solid time management, organizational and note taking skills during fieldwork
- x. **Ethics of fieldwork:** Fieldwork is an educational process with commitment to positive values. All fieldwork should be planned and conducted in a way that is ethical, responsible and safe, for people, students, visited communities, if any, and all other stakeholders. Student is expected to maintain integrity and honesty. Avoid bias and deception. Protect the rights and well-being of people involved in fieldwork. The privacy, confidentiality and respect for the eminent people interacted should be maintained and their time, inputs & guidance are to be acknowledged
- xi. Student is expected to take care of health and Safety practices for fieldwork and travel
- xii. Student should remember that contrary to a *field trip or company visit*, **the emphasis in fieldwork is on acquiring skills**, and not on casually presenting theory and assessing.
- xiii. For the fieldwork, student shall go with a scientifically designed questionnaire and record the responses during interaction. These response sheets, along with geo-tagged pic of fieldwork (at the time of interaction & practice sessions, if any) shall be appended as annexures in the report to be submitted for course evaluation.
- xiv. **Feedback:** The learnings the student made out of interaction with eminent achievers shall be presented in the report as one of the chapters.
- During feedback, the central focus is on the elaboration of the students' experience during fieldwork. Therefore, the student should create an end product, such as a demonstration/presentation and report in which they demonstrate a link between their experiences during fieldwork and the underlying theoretical concepts and ideas.

- (e) **Demonstration/ Presentation and Report:** Student after presentation/demonstration

of his/her achievements/work, shall get a certificate from the concerned nodal unit and submit a report, in the prescribed format, to the faculty counsellor for award of grade.

(f) **Flow process for completion of SEA/SAA course:**

- i. **Faculty counsellor approval:** In week (-1), in consultation with faculty counsellor, every student shall, identifies minimum of 4 activities listed under SEA/SAA activities, lists their priority and fills the same in ONLINE REGISTRATION FORM FOR SEA/SAA (received in their domain mail id) to Dean, Student Affairs. Dean, Student Affairs shall release the section wise allotment of SEA/SAA courses to students along with the details of supervising faculty of nodal center. The allotment details shall be shared to the SEA/SAA coordinator and the student through domain mail id of the student
- ii. **Identification of goals and preparation of action plan:** In week (1), the respective faculty coordinator(s) of nodal centers shall address the students allotted to them to educate them on fixing goals, plan of action for completion and evaluation. In consultation with nodal center, based on the workflow of the allotted activity, every student shall identify the goals (of activity) & eminent personalities (to be visited during the field trip) and prepare action plan (oriented workflow) for attaining the identified goals.
- iii. **Field work:** Under the guidance of nodal center, student shall complete the field work, based on the action plan, with the progress continuously monitored by the faculty counsellor and the nodal center.
- iv. **Demonstration/ Presentation:** After completion of field work, student shall demonstrate/present his achievements (knowledge/skills gained during the activity) at the nodal center in the presence of external experts/senior practitioners of the activity. After successful demonstration/presentation, the nodal center shall provide a certificate of completion indicating that the student has completed the activity in the stipulated time.
- v. **Report writing:** After successful demonstration/presentation, student shall write a 2-3-page report and submit the same to the faculty counsellor. The report shall emphasize knowledge, skills and qualities acquired through the SEA/SAA activities. It shall also include the influence of these activities on enhancing confidence, positive change in life, decision making, transforming choices into desired actions/outcomes.

- (g) **Assessment & Evaluation:** There shall be *only Continuous Internal Evaluation (CIE)* for SEA/SAA. The SEA/SAA activities shall be evaluated at the end of the semester through respective evaluation processes, which shall include field work, presentation/ demonstration, submission of reports on the gathered data/information/ surveys, the details of which have been shown in below table. The department level SEA/SAA coordinator shall collect marks from the nodal centers and faculty counsellors, consolidate them, and submit the final grades to the

examination branch, within one week of the last day of instruction. Evaluation of SEA/SAA activities shall be completed as and when students are ready, but not later than week (N+1).

The CIE for SEA/SAA is as follows:

| Assessment                                     | Maximum marks | Marks to be awarded by |
|------------------------------------------------|---------------|------------------------|
| Goal setting, Planning & Knowledge Acquisition | 20            | Nodal center           |
| Field work                                     | 40            | Nodal center           |
| Demonstration/Presentation                     | 20            | Nodal center           |
| Report submission                              | 20            | Faculty counsellor     |
| <b>Total</b>                                   | <b>100</b>    | <b>-</b>               |

**Note:**

- (a) **Presentation/ Demonstration:** It is mandatory for the student to appear for demonstration and (or) oral presentation oral presentation to qualify for course evaluation. In case of presentation, student should prepare PPT with informative slides including the geo tagged photos of his/her field trips/interactions as per the schedule notified by the nodal center. In case of demonstration, student must take timeslot from the nodal center and demonstrate the skills learnt/improved during the allotted timeslot.
  - The necessary arrangements for demonstration shall be looked after the student in consultation with the coordinator with due permission from Head of the department.
- (b) **Report:** Each student is required to submit a well-documented report on the chosen SEA/SAA topic as per the format specified by *department level SEA/SAA coordinator*.
- (c) **Anti-Plagiarism Check:** The SEA/SAA report should clear plagiarism check as per the Anti-Plagiarism policy of the institute.
- (d) **Requirements for passing the course:** A student is deemed to have passed SEA/SAA if he/she
  - a. successfully demonstrates/presents the skills attained at the end of course as per the schedule notified by the nodal center, **and**
  - b. scores a minimum of 40 marks in the CIE of the course
- (e) **Supplementary examination:** If a student fails in SEA/SAA activity of a particular semester, he must complete the same by enrolling it in the next higher semesters.

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

- CO1:** integrate the five dimensions of physical, emotional, cognitive, spiritual and social aspects in life for holistic development and demonstrate social sensibility
- CO2:** interact effectively through written, oral and nonverbal communication with external-world in a professional, sensitive and culturally relevant manner
- CO3:** analyses the issues related to social empowerment / self-accomplishment, demonstrate problem-solving skills, articulate solutions and demonstrate social sensibility
- CO4:** demonstrate the generic competencies in making a well-documented report and an effective oral presentation with PPTs portraying knowledge, skills, qualities acquired through fieldwork/ practice sessions and social impact of the course learning

**Text / Reference Book(s):**

*For knowledge acquisition, students shall refer to textbooks and web resources relevant to the course selected. Plan for fieldwork/practice sessions in coordination with SEA/SAA coordinator*

| Course Articulation Matrix (CAM): |                 | U24VA109XXXXX- Courses listed under SEA/ SAA |      |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-----------------|----------------------------------------------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |                 | PO 1                                         | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24VA109XXXXX.1 | -                                            | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| CO2                               | U24VA109XXXXX.2 | -                                            | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| CO3                               | U24VA109XXXXX.3 | -                                            | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| CO4                               | U24VA109XXXXX.4 | -                                            | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| U24VA109XXXXX                     |                 | -                                            | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |                 |                                              |      |      |      |      |      |      |      |      |       |       |       |       |

**Course Code: U24VA XXY(SE/SA) ZZZ**

**X** represents semester; **YY** represents SEA/SAA course serial number in that semester; **SE-** represents SEA activity or **SA** – represents SAA activity; **ZZZ** represents activity code from SEA/SAA baskets

|                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex: If A student selects a SEA/SAA course as below:                                                                                                                                                                                                                                                           | Ex: If A student selects a SEA/SAA course as below:                                                                                                                                                                                                                                                           |
| Semester: <span style="color: red;">1</span><br>SEA/SAA course serial number: <span style="color: red;">09</span><br>SEA/SAA category: <span style="color: red;">SEA</span><br>course number: <span style="color: red;">302</span><br>The course code will be U24VA <span style="color: red;">109SE302</span> | Semester: <span style="color: red;">4</span><br>SEA/SAA course serial number: <span style="color: red;">10</span><br>SEA/SAA category: <span style="color: red;">SAA</span><br>course number: <span style="color: red;">206</span><br>The course code will be U24VA <span style="color: red;">410SA206</span> |

| EXPERT TALK SERIES – 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------|------|
| Class: B.Tech. I semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           | Branch: Common to all branches |      |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | U24AE110  | Credits:                       | 1    |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0-0-0-1-1 | CIE:                           | 100% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | -         | ESE:                           | -    |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> 21 <sup>st</sup> century skills needed for industry, current industry trends, challenges and innovations<br><b>LO2:</b> latest technology in practice and applying knowledge to solve real-world problems<br><b>LO3:</b> smart work, soft skills, professional etiquette, networking abilities<br><b>LO4:</b> making a well-documented report portraying the knowledge, skills, qualities acquired and the impact of the learning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                                |      |
| <b>In the 21<sup>st</sup> century, for successful career, degree alone won't suffice. Competencies are much more important.</b><br>(a) You need to be aware of the real-world problems, industry working style, need to be confident and smart and you also need to know the tricks of the trade.<br>(b) Learning from industry experts with real-world examples, is important to enhance your educational experience.<br>(c) Enhanced graduate employability benefits all stakeholders. To effectively enhance employability and the immediacy of adding value to company/project, it is important that you are aware of what you are learning and its use in the workplace. The cognitive abilities viz., remember, understand, recall, and application of knowledge and other skills acquired in higher education can be maximized if you are clear on the purpose of your developed competencies and how to apply them in a range of complex situations.<br>(d) Graduate employability could be enhanced through fostering lifelong learning, the development of a range of employability-related competencies and increased confidence and capacity in "reflecting on and articulating these capabilities and attributes in a range of recruitment situations".<br><b>But how would you know all this without venturing into the industry?</b><br>(e) The answer is Industry <b>Expert Talk Series (ETS)</b> . Through ETS, we invite industry experts in different fields to deliver talks and interact with students.<br>(f) Through Industry expert talks students get to know so much more that textbooks don't explain.<br>(g) Students have the opportunity to learn from professionals who have achieved success in their respective fields. These speakers often share their personal experiences, case studies, and anecdotes, providing students with real-world examples and perspectives that go beyond |           |                                |      |

theoretical concepts.

- (h) Our competency-focused curriculum URR24 is designed to contribute greatly to the nurturing and development of each of these facets among students through ETS courses
- (i) ETS helps students gain improved industry engagement for an easier transition into the workplace, broader career progression opportunities and personal development.
- (j) In URR24 curriculum, Expert talk series (ETS) is offered as a course under **ability enhancement category of courses**.
- (k) Through ETS sessions, students get the chance to interact with industry regularly which helps them focus on the needs and requirements of current industry. This will not only enthuse the students with new ideas but also motivate them to understand what kind of 21<sup>st</sup> century skills are needed in industry and how they need to groom themselves.
- (l) Through ETS sessions, another benefit is that students learn the importance of soft skills like communication, presentation, email etiquettes, corporate grooming and dressing styles. Conversing with successful people is the biggest motivation and students gain in more ways than one through ETS sessions.
- (m) ETS enhances your learning in many ways for global opportunities for your career.
- (n) All in all, learning from industry experts, is a wonderful opportunity for student to getting acquainted with professional etiquette, acquiring professional knowledge, and getting to know the internal workings of an organization.
- (o) Salient features of ETS are hereunder:
  - (i) ETS is offered from I semester to VI semester.
  - (ii) ETS, in any given semester, is treated as one credit course
  - (iii) Students are required to earn six credits (from I to VI semester)
  - (iv) **Head, Centre for i<sup>2</sup>RE** shall be the **institute level ETS coordinator**
  - (v) Under this course, a minimum of 10 expert talks shall be organized in **online/offline mode** by the parent department / Centre for i<sup>2</sup>RE.
  - (vi) Each expert talk shall be for a minimum duration of 45 minutes (*but not exceeding 90 minutes*) followed by **online quiz/test** for 10 marks (10 MCQs/FiBs; *duration: 10-15 mins*), on the contents covered in the expert talk.
  - (vii) **The Head C-i<sup>2</sup>RE** shall share the marks obtained by the students in each of the quizzes / tests to the respective **department ETS coordinators**.
  - (viii) Each student shall attend a minimum of 6 expert talks and attempt the corresponding quizzes/ tests conducted at the end of the talks.
  - (ix) **Report on ETS:** At the end of semester, the student shall submit a well-documented

report on the acquired knowledge and skills, in the prescribed format, to the department ETS coordinator.

- (x) **Evaluation:** There shall be only continuous Internal Evaluation (CIE) for ETS for a maximum of 100 marks
- (xi) The department ETS coordinator shall, in coordination with institute level ETS coordinator, submit the final scores to the CoE in week (N+1).
- (p) The CIE for ETS is as follows:

*Rubrics for evaluation of ETS*

|                                                                                               |           |
|-----------------------------------------------------------------------------------------------|-----------|
| Quiz score<br>(Sum of best 6 quiz scores out of 10 quizzes. Each quiz evaluated for 10 marks) | 60 marks  |
| Attendance (out of 10 quizzes)                                                                | 20 marks  |
| Report in prescribed format (max 30% plagiarism)                                              | 20 marks  |
| <b>Total</b>                                                                                  | 100 marks |

- i. **Attendance:** Maximum of 20 marks shall be awarded based on the attendance maintained by the student over a maximum of 10 lectures.

$$\text{Marks for attendance} = \frac{\text{Number of expert talks attended fully}}{10} * 20$$

**ii. Supplementary Exam:**

- (a) Student has to register for ETS supplementary examination if he/she scores less than 40 marks in CIE
- (b) The ETS supplementary examination shall be conducted by the parent department, in physical mode, for 100 marks (MCQs/FiBs;duration: 2Hrs) on the content covered in ETS lectures.
- (c) Department ETS coordinator shall, in coordination with the institute level ETS coordinator, conduct the supplementary exam, and submit scores to the CoE
- (d) Exam material/resources for supplementary: Recorded videos of ETS arranged for that semester, which shall be made available on ETS webpage of institute website

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

- CO1:** identify real-world problems, different career paths, industry requirements, emerging job roles, business practices and exploit new opportunities by staying up-to-date with industry knowledge, trends and technology
- CO2:** identify what 21<sup>st</sup> century employability-related skills and professional etiquette are must in a range of recruitment situations, what skills are absent in him/her, and demonstrate skill improvement
- CO3:** interact with experts, exhibit confidence, demonstrate improved communication and networking abilities potentially leading to mentorship opportunities, internships, or even future job prospects
- CO4:** demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through ETS sessions and impact of the expert talks

| Course Articulation Matrix (CAM): |            |      |      | U24AE110 EXPERT TALK SERIES - 1 |      |      |      |      |      |      |       |       |      |       |
|-----------------------------------|------------|------|------|---------------------------------|------|------|------|------|------|------|-------|-------|------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                            | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO1 | PSO 2 |
| CO1                               | U24AE110.1 | 1    | 1    | 1                               | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1    | 1     |
| CO2                               | U24AE110.2 | 1    | 1    | 1                               | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1    | 1     |
| CO3                               | U24AE110.3 | 1    | 1    | 1                               | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1    | 1     |
| CO4                               | U24AE110.4 | 1    | 1    | 1                               | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1    | 1     |
| U24AE110                          |            | 1    | 1    | 1                               | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1    | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                                 |      |      |      |      |      |      |       |       |      |       |

**Course code U24AE1YY:** *X represents semester, YY represents ETA course serial number*

# 2<sup>nd</sup> Semester Syllabus

## II SEMESTER

| S. No.                                                                                                                                                                        | Category | Course Code       | Course Title                                | Lectures / week |   |    |    |    | Credits |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------|---------------------------------------------|-----------------|---|----|----|----|---------|
|                                                                                                                                                                               |          |                   |                                             | L               | T | P  | O  | E  |         |
| 1                                                                                                                                                                             | BSC      | U24MH201          | Matrix Theory and Vector Calculus           | 2               | 1 | -  | 6  | 9  | 3       |
| 2                                                                                                                                                                             | BSC      | U24CY202E         | Engineering Chemistry<br>(for ECE)          | 2               | 1 | 2  | 5  | 10 | 4       |
| 3                                                                                                                                                                             | PCC      | U24EC203          | Electronic Circuits                         | 2               | 1 | -  | 4  | 7  | 3       |
| 4                                                                                                                                                                             | ESC      | U24EC204          | Data Structures through C                   | 2               | 1 | 2  | 5  | 10 | 4       |
| 5                                                                                                                                                                             | HSMC     | U24MH205          | English Communication and Report Writing    | 2               | - | -  | 3  | 5  | 2       |
| 6                                                                                                                                                                             | VAC      | U24VA206          | Sports and Yoga                             | -               | - | 2  | 2  | 4  | -       |
| 7                                                                                                                                                                             | ESC      | U24ME207          | Engineering Graphics through CAD            | -               | - | 2  | 2  | 4  | 1       |
| 8                                                                                                                                                                             | SEC      | U24SE208          | Programming Skill Development (PSD) Lab - 1 | -               | - | 2  | 2  | 4  | 1       |
| 9                                                                                                                                                                             | ELC      | U24EL209          | Practicum-2                                 | -               | - | -  | 4  | 4  | 1       |
| 10                                                                                                                                                                            | VAC      | U24VA210XX<br>XXX | SEA-2 / SAA -2                              | -               | - | -  | 2  | 2  | 1       |
| 11                                                                                                                                                                            | AEC      | U24AE211          | Expert Talk Series-2                        | -               | - | -  | 1  | 1  | 1       |
| Total:                                                                                                                                                                        |          |                   |                                             | 10              | 4 | 10 | 36 | 60 | 21      |
| Summer/ Inter-Sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet) |          |                   |                                             | -               | - | -  | -  | -  | -       |

### Exit Option to Qualify **UG Certificate in ECE**: Any Two (02) Courses during the 2 - Months internship

| S. No. | Category | Course Code | Course Title                                       | L | T | P | O | E | C |
|--------|----------|-------------|----------------------------------------------------|---|---|---|---|---|---|
| 1      | PCC      | U24EC212X   | Industrial Electronics                             | 2 | - | 2 | - | 4 | 3 |
| 2      | PCC      | U24EC213X   | Electronic Measuring Instruments                   | 2 | - | 2 | - | 4 | 3 |
| 3      | PCC      | U24EC214X   | PCB Design and Fabrication                         | 2 | - | 2 | - | 4 | 3 |
| 4      | PCC      | U24EC215X   | Any other course approved by BoS Chair and Dean AA | 2 | - | 2 | - | 4 | 3 |

| MATRIX THEORY AND VECTOR CALCULUS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |                                |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------|-------|
| Class: B.Tech. II -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           | Branch: Common to all branches |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | U24MH201  | Credits:                       | 3     |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2-1-0-6-9 | CIE:                           | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 36 Hrs    | ESE:                           | 40%   |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> various methods of solving system of linear equations and eigen value problems<br><b>LO2:</b> double integral, triple integral and their applications<br><b>LO3:</b> vector differential calculus and applications<br><b>LO4:</b> integration of vector valued functions and applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                                |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                                | 9 Hrs |
| <b>Matrices:</b><br>Rank of a Matrix, Elementary transformations of a matrix, Gauss Jordan method of finding the inverse, Normal form of a matrix, Consistency of linear system of equations, System of linear homogenous equations, Vectors-Linear dependence and independence, Eigen values, Eigen vectors, Properties of Eigen values, Cayley Hamilton's theorem, Reduction to diagonal form, Factorization method (LU Decomposition)<br><b>Applications of Eigen value problems:</b> Stretching of an elastic membrane, Eigen value problems arising from Markov processes, Eigen value problems arising from population models, Leslie model<br><b>Self-Learning Topics (SLTs):</b> Review of Matrices [Text 1: topics 2.1,2.2,2.3,2.4,2.5], PAQ –Normal form [Text 1, topic 2.7(7), Solved problems: 2.26, Practice problems: exercise 2.4 (9,10)], Additional problems on System of homogeneous and non-homogeneous equations [Text 1: topic 2.18, Solved problems: 2.52, Practice problems: exercise 2.10 (13,14)], Additional problems on Eigen values and Eigen vectors [Text 2: topic 8.1, Solved problems: 8.1(1,2), Practice problems: exercise 8.1(4,6)], Nature of Quadratic form [Text 1: topic 2.18, Solved problems: 2.52, Practice problems: exercise 2.10 (13,14)] |           |                                |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                | 9 Hrs |
| <b>Multiple Integrals and Beta, Gamma functions:</b><br>Double Integrals, change of order of integration, Double Integrals in polar coordinates, Area enclosed by plane curves, Triple integrals, Volumes of solids, Calculation of Mass for a plane lamina, Beta function, Gamma function, Relation between Beta and Gamma functions (without proof)<br><b>Self-Learning Topics (SLTs):</b> Review of integrals [Text 1: topic Appendix VII (1)], Additional problems on change of order of integration [Text 1: topic 7.2, Solved problems: 7.4,7.6, Practice problems: exercise 7.1 (9,14)], Centre of gravity of a plane lamina [Text 1: topic 7.10, Solved problems 7.34,7.35, Practice problems: exercise 7.6 (9,10)], Moment of Inertia of plane lamina [Text 1: topic 7.12(1,2), Solved problems: 7.37,7.38, Practice problems: exercise 7.7 (1,4)], Additional problems on Volume of solids [Text 1: topic 7.6, Solved problem: 7.21, Practice problems: exercise 7.4 (12,25)]                                                                                                                                                                                                                                                                                                |           |                                |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |                                | 9 Hrs |
| <b>Vector Calculus and its applications:</b> - Differentiation of vectors, Curves in space, Tangent, Principal normal, Binormal, Curvature, Torsion, Velocity and acceleration, Scalar and vector point                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                |       |

functions, Del applied to scalar point functions - Gradient, Geometrical interpretation, Directional derivative, Del applied to vector point functions -Divergence, Curl, Physical interpretation of divergence, Physical interpretation of curl, Del applied twice to point functions, Del applied to products of point functions

**Self-Learning Topics (SLTs):** Review of vectors [Text 2: topics 9.1, 9.2, 9.3], Vector identities [Text 1: topic 8.9, Solved problems: 8.22, 8.23, Practice problems: exercise 8.4 (13,14)], Additional problems on Directional derivatives [Text 1: topic 8.5(3), Solved problems: 8.13,8.14, Practice problems: exercise 8.3 (4,6,8,9)].

#### UNIT-IV

9 Hrs

#### Integration of vectors:

Line integral, Surfaces-Surface integral, flux across a surface, Green's theorem in the plane (without proof), Stoke's theorem (Relation between line and surface integrals) (without proof), Volume integral, Gauss divergence theorem (Relation between surface and volume integrals) (without proof), irrotational fields, solenoidal fields

**Self-Learning Topics (SLTs):** Additional problems on Green's theorem [Text 1: topic 8.13, Solved problems: 8.33,8.35, Practice problems: exercise 8.8 (1,2,4)], Additional problems on Stoke's theorem [Text 1: topics 8.14, Solved problems: 8.39, 8.40, Practice problems: exercise 8.9 (1,2)], Additional problems on Gauss Divergence theorem [Text 1: topic 8.16, Solved problems: 8.44,8.46, Practice problems: exercise 8.10 (1,2)]

#### Course Learning Outcomes (COs):

After completion of this course, the students should be able to...

**CO1:** analyze eigen value problems using matrix theory

**CO2:** apply basic concepts of multiple integrals in evaluating physical quantities of real-life engineering problems

**CO3:** apply differential operators on vector and scalar point functions

**CO4:** solve line, surface, volume integrals and correlate these with applications of Green, Stoke and Gauss divergence theorems

#### TextBook(s):

1. Grewal, B.S., *Higher Engineering Mathematics*, Khanna Publishers, Delhi, 44thed. 2017 (Chapters 2,7,8)
2. Kreyszig E, *Advanced Engineering Mathematics*, Inc, U.K, John Wiley&sons, 10thed. 2020 (Chapter 8(8.2))

#### Reference Book(s):

1. Spiegel M, *Vector Analysis -Schaum's Serie"*, McGraw Hill,2nded. 2017
2. S.S. Sastry, *Engineering Mathematics, Vol.II*, Prentice Hall of India, 3rded. 2014

#### Web and Video link(s):

1. <https://youtu.be/L4crGhtEX14?si=hyjAPgDheJOhXtYZ> : NPTEL Video Lecture on Matrix Analysis with Applications/Dr.S.K.Gupta and Dr.Sanjeev Kumar/IIT Roorkee
2. [https://youtu.be/ksS\\_yOK1vvtk?si=CNNA58OIuszubPiX](https://youtu.be/ksS_yOK1vvtk?si=CNNA58OIuszubPiX) : NPTEL Video Lecture on Integral and Vector Calculus./Prof.Hari Shankar Mahato / IIT Kharagpur

| Course Articulation Matrix (CAM): |            |      |      |      | U24MH201 MATRIX THEORY AND VECTOR CALCULUS |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|--------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                                       | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24MH201.1 | 2    | 2    | 1    | 1                                          | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO2                               | U24MH201.2 | 2    | 2    | 1    | 1                                          | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO3                               | U24MH201.3 | 2    | 2    | 1    | 1                                          | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO4                               | U24MH201.4 | 2    | 2    | 1    | 1                                          | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| U24MH201                          |            | 2    | 2    | 1    | 1                                          | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |      |                                            |      |      |      |      |      |       |       |       |       |

| ENGINEERING CHEMISTRY (for ECE)                                                                                                                                                                                                                                                                                                                                                              |            |             |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-----|
| Class: B.Tech. II-Semester                                                                                                                                                                                                                                                                                                                                                                   |            | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                 | U24CY202E  | Credits:    | 4   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                      | 2-1-2-5-10 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                              | 60Hrs      | ESE:        | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                                                                            |            |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                                                                       |            |             |     |
| LO1: electrochemical energy systems, batteries and fuel cells                                                                                                                                                                                                                                                                                                                                |            |             |     |
| LO2: water analysis and corrosion with its preventive methods                                                                                                                                                                                                                                                                                                                                |            |             |     |
| LO3:spectroscopic techniques and polymers                                                                                                                                                                                                                                                                                                                                                    |            |             |     |
| LO4: synthesis, properties and applications of nanomaterials                                                                                                                                                                                                                                                                                                                                 |            |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                                                                             |            |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                       |            | 9 Hrs       |     |
| Electrochemical Energy Systems:Specificconductance, Equivalentconductance, Effectofdilution; Conductometric titrations-Acid base titrations-Strong acid vs strong base, Weak acid vs strong base, Strong acid vs weak base and weak acid vs weak base; Electrodepotential, pH meter, Principle of pHmeasurements, Electrodes, Nernstequation, Potentiometric titrations-Acid base titrations |            |             |     |
| Batteries: Primary and secondary batteries-Lead-acid battery, Li-ion battery                                                                                                                                                                                                                                                                                                                 |            |             |     |
| Fuelcells: Hydrogen-oxygenfuelcell                                                                                                                                                                                                                                                                                                                                                           |            |             |     |
| Self-Learning Topics (SLTs): Types of conductors (Text1:chapter 5 topic 1), Ohms law (Text 1:chapter 5 topic 5)                                                                                                                                                                                                                                                                              |            |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                      |            | 9 Hrs       |     |
| Water Technology: Introduction, Hardness ofwater, Estimation of hardness of water bycomplexometry, Alkalinity, Determination of alkalinity, Numerical problems, Determination offluoride by spectrophotometry, Ion-exchange method, Desalination of brackish water, Reverse osmosis (RO), Electro dialysis, Quality parameters of potable water (BIS and WHO)                                |            |             |     |
| Corrosion: Introduction, Dry corrosion, Wet corrosion, Pilling-Bedworth rule, Effect of purity, Relative areas of anodic and cathodic parts, Nature of surface film, Humidity, pHand temperature on corrosion, Cathodic protection, Impressed current cathodic protection, Sacrificial anodic protection, Electroplating                                                                     |            |             |     |
| Self-Learning Topics (SLTs): Units of hardness (Text1: chapter 1 topic 5), Introduction to corrosion (Text1:chapter 7 topic 1), Galvanic series (Text1: chapter 7 topic 12)                                                                                                                                                                                                                  |            |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                     |            | 9 Hrs       |     |
| Spectroscopy: Introduction to spectroscopy                                                                                                                                                                                                                                                                                                                                                   |            |             |     |
| Microwavespectroscopy-Principle, Selection rules, Applications                                                                                                                                                                                                                                                                                                                               |            |             |     |
| Infra-red spectroscopy-Principle, Selection rules, Applications                                                                                                                                                                                                                                                                                                                              |            |             |     |
| UV Spectroscopy-Lambert-Beer'slawandits applications                                                                                                                                                                                                                                                                                                                                         |            |             |     |
| Polymers: Polymer, Monomer, Condensation polymerization, Thermo-setting andthermoplasticresins, Applications of bakelite and poly vinyl chloride (PVC)                                                                                                                                                                                                                                       |            |             |     |
| Self-Learning Topics (SLTs): Electromagnetic spectrum (Text1:chapter 35 topic 1), Atomic absorption                                                                                                                                                                                                                                                                                          |            |             |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| spectroscopy (Text1:chapter 35 topic 28) mechanism of addition Polymerization (Text1:chapter 3 topic 6)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>9 Hrs</b> |
| <b>Engineering Materials</b><br><b>Nanomaterials:</b> Introduction, Size dependent properties-Surface area, Electrical, Optical and catalytic properties; Synthesis of nanomaterials-Top down and bottom-up approaches, Synthesis by sol-gel and precipitation method<br><b>Nanoscale materials:</b> Fullerenes, Carbon nanotubes, 2D nanomaterials-graphene, Properties and applications; Biosensors<br><b>Self-Learning Topics (SLTs):</b> Introduction to nanotechnology (Text1:chapter 37 topic 1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |
| <b>LABORATORY COMPONENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |
| <p style="text-align: center;"><b>List of Experiments</b></p> <ol style="list-style-type: none"> <li>1. Estimation of hydroxide ion [OH<sup>-</sup>] by acidimetry using standard sodium carbonate solution</li> <li>2. Estimation of alkalinity of water sample containing (i) carbonate; (ii) carbonate &amp; bi carbonate in ground water</li> <li>3. Estimation of alkalinity of water sample containing (i) bicarbonate; (ii) carbonate &amp; hydroxide in potable water</li> <li>4. Determination of hardness of water by complexometric method</li> <li>5. Determination of dissolved oxygen in a sample of water</li> <li>6. Standardization of sodium hydroxide (NaOH) by conductometry using standard hydrochloric acid (HCl)</li> <li>7. Standardization of acetic acid (CH<sub>3</sub>COOH) by conductometry using standard sodium hydroxide (NaOH)</li> <li>8. Standardization of strong acid hydrochloric acid (HCl) by potentiometry using standard sodium hydroxide (NaOH)</li> <li>9. Colorimetric analysis-verification of Lambert-Beer's law</li> <li>10. Estimation of ferrous (Fe<sup>2+</sup>) ion in the given solution using potassium permanganate</li> <li>11. Preparation of nanoparticles of cadmium sulphide (CdS)</li> <li>12. Synthesis of polymer (phenol- formaldehyde)</li> </ol> |              |
| <b><u>TextBook(s):</u></b><br>1. Jain and Jain, <i>Engineering Chemistry</i> , Dhanpat Rai Publishing Company, 17th ed. 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |
| <b><u>Reference Book(s):</u></b><br><ol style="list-style-type: none"> <li>1. J.C.Kuriacose and J.Rajaram, <i>Chemistry in Engineering and Technology</i>(vol.I &amp; vol.II), Tata Mc. Graw-Hills Education Pvt. Ltd., 2010</li> <li>2. Shashi Chawla, <i>Text book of Engineering Chemistry</i>, Dhanpat Rai Publishers, 3rd ed. 2003</li> <li>3. S.S. Dara, S. S. Umare, <i>A Text book of Engineering Chemistry</i>, S.Chand &amp; Company Ltd., 12th ed. 2010</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |
| <b><u>Web and Video link(s):</u></b><br><ol style="list-style-type: none"> <li>1. <a href="https://elearn.nptel.ac.in/shop/iit-workshops/completed/battery-cell-technology-materials-and-industrial-applications/?v=c86ee0d9d7ed">https://elearn.nptel.ac.in/shop/iit-workshops/completed/battery-cell-technology-materials-and-industrial-applications/?v=c86ee0d9d7ed</a> NPTEL Video Lecture on Battery technology by Dr. Kothandaraman, Professor of Chemistry, IIT Madras &amp; Dr. Raghunathan, Professor of Chemical engineering, IIT Madras</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |

**Laboratory Manual (for laboratory component):**

1. *Engineering Chemistry laboratory manual*, Department of PS, KITSW

**Course Learning Outcomes (COs)**

*After completion of this course, the students should be able to...*

**CO1:** apply the concepts of electrochemical energy systems for batteries and fuel cells

**CO2:** interpret suitable techniques of water analysis and corrosion treatment of solid materials

**CO3:** appraise spectroscopic techniques of chemical analysis and applications of polymers

**CO4:** summarize the synthesis of nanomaterials and their applications

*(based on psychomotor skills acquired from laboratory component)*

**CO5:** estimate hydroxide ion and alkalinity of water sample

**CO6:** determine total hardness and oxygen dissolved in water

**CO7:** calculate molarities of acids and bases

**CO8:** prepare nanomaterials and polymers

| Course Articulation Matrix (CAM): |             |      |      | U24CY202ENGINEERING CHEMISTRY (for ECE) |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|------|------|-----------------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1 | PO 2 | PO 3                                    | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24CY202E.1 | 2    | -    | -                                       | -    | 1    | 1    | 1    | -    | 1    | -     | 1     | 1     | -     |
| CO2                               | U24CY202E.2 | 2    | -    | -                                       | -    | 1    | 1    | 1    | -    | 1    | -     | 1     | 1     | -     |
| CO3                               | U24CY202E.3 | 2    | 2    | 2                                       | 2    | 1    | 1    | 1    | 1    | -    | -     | -     | 1     | -     |
| CO4                               | U24CY202E.4 | 2    | 2    | 1                                       | 1    | 1    | 1    | 1    | 1    | -    | -     | -     | 1     | -     |
| CO5                               | U24CY202E.5 | 2    | 1    | -                                       | -    | -    | 1    | 1    | -    | 1    | -     | 1     | 1     | -     |
| CO6                               | U24CY202E.6 | 2    | 1    | -                                       | -    | 2    | 1    | 1    | -    | 1    | -     | 1     | 1     | -     |
| CO7                               | U24CY202E.7 | 2    | 1    | -                                       | -    | -    | 1    | 1    | -    | 1    | -     | 1     | 1     | -     |
| CO8                               | U24CY202E.8 | 2    | 1    | -                                       | -    | -    | 1    | 1    | -    | 1    | -     | 1     | 1     | -     |
| U24CY202E                         |             | 2    | 1    | 1.5                                     | 1.5  | 1.2  | 1    | 1    | 1    | 1    | -     | 1     | 1     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |      |                                         |      |      |      |      |      |      |       |       |       |       |

| ELECTRONIC CIRCUITS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |             |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-----|
| Class: B.Tech. II -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | U24EC203  | Credits:    | 3   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2-1-0-4-7 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 36 Hrs.   | ESE:        | 40% |
| Course Learning Objectives (LOs):<br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> half wave, full wave rectifiers and non-linear wave shaping<br><b>LO2:</b> transistor biasing and thermal stabilization<br><b>LO3:</b> FET characteristics, its operation, biasing<br><b>LO4:</b> Small signal low frequency transistor amplifier circuits                                                                                                                                                                                                                                                                                                                                   |           |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           | 9 Hrs       |     |
| Review of conduction in semiconductors and PN Junction Diode<br><b>Rectifiers:</b> Half Wave Rectifier, Full wave Rectifier, Harmonic Components in Rectifier Circuits, Inductor Filter, Capacitor Filter, L - Section Filter, and $\pi$ - Section Filter<br><b>Non-Linear Wave Shaping Circuits:</b> Clipping Circuits - Diode Clippers, Shunt Clippers, Series Clippers, clipping at two Independent Levels; The Clamping Operation, Clamping Circuits with source and diode Resistances and Clamping Circuit Theorem<br><i>Self-Learning Topics (SLTs): solved problems (Text1: Prob 2.10, 2.14, 2.16, 2.19, 2.30), Clipping circuits (Text2: topic 7.2)</i>                                                |           |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           | 9 Hrs       |     |
| Review of BJT characteristics in CB, CE and CC configurations<br><b>Transistor Biasing &amp; Thermal Stabilization:</b> The Operating Point (Q-point), Bias stability, stability of operating point, stability factor (S), fixed bias, Collector to Base Bias, Self-Bias, Stabilization against variations in $V_{BE}$ and $\beta$ for the Self Bias Circuit ( $S'$ & $S''$ ), Bias Compensation using diode, thermal runaway, thermal Stability<br><i>Self-Learning Topics (SLTs): Solved problems (Text1: Prob 4.12, 4.14, 4.15), Solved problems (Text1: Prob 4.30, 4.31)</i>                                                                                                                               |           |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           | 9 Hrs       |     |
| <b>Field Effect Transistors:</b> Construction and operation of Junction Field Effect Transistor (JFET), Volt-Ampere characteristics- Drain and Transfer Characteristics, Comparison of BJT and FET, FET as Voltage Variable Resistor, Construction and operation of MOSFET, MOSFET characteristics in Enhancement and Depletion modes, MOSTET as a capacitor<br><b>FET Biasing:</b> Fixed Bias Configuration, Self-Bias Configuration, Common Gate Configuration, Common Drain Configuration<br><i>Self-Learning Topics (SLTs):</i> Drain saturation current (Text1: topic 5.5), Solved problems (Text1: Prob 5.5, 5.6,), Voltage divider bias (Text1: topic 5.22.3), Solved problems (Text1: Prob 5.16, 5.17) |           |             |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           | 9 Hrs       |     |
| <b>Small Signal Low Frequency Transistor Amplifier Circuits:</b> Transistor Hybrid model, Typical values of h- parameters in CE, CB and CC configurations, Analysis of CE, CC, CB Amplifiers and CE Amplifier with emitter resistance, low frequency response of BJT Amplifiers, effect of coupling and bypass capacitors on CE Amplifier                                                                                                                                                                                                                                                                                                                                                                      |           |             |     |

**Self-Learning Topics (SLTs):** Simplified calculations for the common collector configuration (Ref Text1: topic 12.5), Simplified calculations for the common emitter configuration with emitter resistance (Ref Text1: topic 12.7)

**Course Learning Outcomes (COs):**

After completion of this course, the students should be able to...

- CO1:** design rectifiers and non-linear wave shaping circuits
- CO2:** calculate the stability factor for a given biasing circuit
- CO3:** explain the operation of different types of FETs and FET biasing
- CO4:** design single stage amplifiers using BJT

**TextBook(s):**

1. S. Salivahananand N Suresh Kumar., *Electronic Devices and Circuits*, 2nd ed. Mc Graw Hill, New Delhi, 2011
2. Jacob Milliman and Hilbert Taub., *Pulse, Digital and switching Waveforms*, 2nd ed. McGraw Hill, 2007

**Reference Book(s):**

1. Jacob Milliman and Christos Halkias, *Electronic Devices and Circuits*, 3rd ed. Mc Graw Hill, New Delhi, 1991
2. A. Anandkumar, *Pulse and Digital Circuits*, 2nd ed. PHI, 2008

**Web and Video link(s):**

1. <https://www.youtube.com/watch?v=h0Y9jDKqScQ&list=PLgMDNELGJ1CaNcuuQv9xN07ZWkXE-wCGP>; NPTEL Video Lecture on fundamentals of semiconductor devices by Prof. Digbijoy.N.Nath, IISC Bangalore.
2. [https://www.youtube.com/watch?v=pkIxCmaxWFg&list=PLbRMhDVUMngehqNF2w\\_UbAi94qIycZOTG](https://www.youtube.com/watch?v=pkIxCmaxWFg&list=PLbRMhDVUMngehqNF2w_UbAi94qIycZOTG); NPTEL Video Lecture on analog electronic circuits by Prof. Pradip Mandal, IIT Kharagpur.

| Course Articulation Matrix (CAM): |            |      |      | U24EC203 ELECTRONIC CIRCUITS |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                         | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC203.1 | 2    | 2    | 1                            | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO2                               | U24EC203.2 | 2    | 2    | 1                            | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO3                               | U24EC203.3 | 2    | 2    | 1                            | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| CO4                               | U24EC203.4 | 2    | 2    | 1                            | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| U24EC203                          |            | 2    | 2    | 1                            | -    | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 1     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |            |      |      |                              |      |      |      |      |      |      |       |       |       |       |

| DATA STRUCTURES THROUGH C                                                                                                                                                                                                                                                                                                                       |            |            |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|-----|
| Class: B.Tech. II –Semester                                                                                                                                                                                                                                                                                                                     |            | Branch:ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                    | U24EC204   | Credits:   | 4   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                         | 2-1-2-5-10 | CIE:       | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                 | 60 Hrs     | ESE:       | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                               |            |            |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                          |            |            |     |
| LO1: time complexity, space complexity, array operations, and dynamic memory allocation                                                                                                                                                                                                                                                         |            |            |     |
| LO2: stacks and various forms of queues                                                                                                                                                                                                                                                                                                         |            |            |     |
| LO3: various types of linked lists                                                                                                                                                                                                                                                                                                              |            |            |     |
| LO4: various sorting techniques and hashing techniques                                                                                                                                                                                                                                                                                          |            |            |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                                |            |            |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                          |            | 9 Hrs      |     |
| <b>Data Structures:</b> Basic terminology, Classification of data structures, Applications and operations on data structures, Time and space complexity                                                                                                                                                                                         |            |            |     |
| <b>Arrays:</b> Operations on arrays-traversing an array, inserting an element in an array, deleting an element from an array, searching an element using binary search and their complexities,                                                                                                                                                  |            |            |     |
| <b>Dynamic Memory Allocation:</b> Memory allocation functions, Dynamic memory allocation for single- and two-dimensional arrays                                                                                                                                                                                                                 |            |            |     |
| <i>Self-Learning Topics (SLTs): Three dimensional and n-dimensional arrays (Text1: topics 2.4.3), passing arrays to functions and pointers (Reference1: topics 3.6, 3.7), Practice problems (Text1: Prob 2.3, Reference1: Prob 1, Prob2, Prob3, Prob 4)</i>                                                                                     |            |            |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                         |            | 9 Hrs      |     |
| <b>Stacks:</b> stacks, Array representation of stacks, Operations on a stack-push and pop; Multiple stacks, Applications of stacks- recursion, Fibonacci series, tower of Hanoi, evaluation of expressions (infix to postfix conversion, evaluation of postfix expression)                                                                      |            |            |     |
| <b>Queues:</b> queues, Array representation of queues, Double ended queues, Circular queues                                                                                                                                                                                                                                                     |            |            |     |
| <i>Self-Learning Topics (SLTs): Infix to prefix (Reference1: topics 7.7.3), priority Queue (Reference1: 8.4.3),Solved problems (Reference1: Prob 7.7.1, Prob 7.7.2), Practice problems (Text1: Prob 4.5, Prob 4.11, Prob 5.7, Prob 5.9)</i>                                                                                                     |            |            |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                        |            | 9 Hrs      |     |
| <b>Linked Lists:</b> Basic terminologies, Linked list versus arrays, Memory allocation and de-allocation for a linked list, singlylinked list, Circular linked list, doubly linked list, Circular doubly linked list (linked list operations- traversing,searching, inserting, deleting), Representing stack and queue using linked list        |            |            |     |
| <i>Self-Learning Topics (SLTs): Merging (Text1: topics 3.3), Skip list (weblink: <a href="https://www.geeksforgeeks.org/skip-list/">https://www.geeksforgeeks.org/skip-list/</a> ), Deallocation strategy (Text1: topic 3.9), Solved problems (Text1: Prob 3.6.1, Prob 3.6.2), Practice problems (Reference1: Prob 5.5, Prob 5.7, Prob 5.9)</i> |            |            |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                         |            | 9 Hrs      |     |
| <b>Sorting Techniques:</b> Selection sort, Insertion Sort, Shell sort and radix sort, Time complexities of sorting                                                                                                                                                                                                                              |            |            |     |
| <b>Hashing:</b> Hashing techniques, Collision resolution techniques, Closed hashing, Open                                                                                                                                                                                                                                                       |            |            |     |

hashing, Comparison of collision resolution techniques

**Self-Learning Topics (SLTs):** Two-way insertion sort (*Text1: topics 10.3.4*), Comparison of sorting techniques (*Reference1: topics 14.16*) Solved problems (*Reference1: Prob 15.5, Prob 15.6, Prob 15.7*), Practice problems (*Text1: Prob 6.4*)

## LABORATORY COMPONENT

### List of Experiments

#### Experiment-I

1. Program to implement initialization of array and perform traversal operations in both the directions
2. Program to implement searching operation on array using Linear Search
3. Program to display the count of occurrences of every number in an array

#### Experiment-II

4. Program to implement searching operation on array using Binary Search
5. Program to implement insertion operation on array
6. Program to implement deletion operations on array

#### Experiment-III

7. Program to implement initialization of arrays and traversal operation with DMA
8. Program to implement matrix addition and subtraction with DMA

#### Experiment-IV

9. Program to implement matrix multiplication with DMA
10. Program to implement stack operations
11. Program to convert infix expression into postfix

#### Experiment-V

12. Program to evaluate given postfix expression
13. Program to define recursive function to solve tower of hanoi puzzle
14. Program to display the Fibonacci series with the help of recursive function
15. Program to implement MultiStack

#### Experiment-VI

16. Program to implement queue operations using arrays
17. Program to implement circular queue operations using arrays
18. Program to implement double ended queue operations using arrays

#### Experiment-VII

19. Program to create single linked list and implement its operations
- Note: -Linked list Operations: i) traversing, ii) inserting, iii) deleting, iv) searching, v) reversing, vi) concatenation

#### Experiment-VIII

20. Program to create circular linked list and implement its operations
21. Program to create double linked list and implement its operations

#### Experiment-IX

22. Program to create circular double linked list and implement its operations

**Experiment-X**

23. Program to implement stack operations using linked list
24. Program to implement queue operations using linked list

**Experiment-XI**

25. Program to implement selection sort
26. Program to implement insertion sort

**Experiment-XII**

27. Program to implement shell sort
28. Program to implement radix sort
29. Program to implement hash table.

**TextBook(s):**

1. Debasis Samanta, *Classic Data Structures*, Prentice Hall India, 2nd ed. 2009

**Reference Book(s):**

1. Reema Thareja, *Data Structures Using C*, Oxford University Press, 2nd ed. 2014
2. Balagurusamy E, *Data Structure Using C*, McGraw Hill Education, 1st ed. 2017
3. Richard F. Gilberg and Behrouz A. Forouzan, *Data Structures: A Pseudocode Approach with C*, Cengage Learning, 2nd ed. 2007

**Web and Video link(s):**

1. <https://nptel.ac.in/courses/106106130>; NPTEL Video Lecture on Programming and Data Structures Dr. N. S. Narayana Swamy, CSE, IIT Madras.

**Laboratory Manual (for laboratory component):**

1. *Data Structures using C Laboratory Manual and Record Book*, Department of ECE, KITSW.

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to,*

- CO1:** analyse and implement array operations by utilizing dynamic memory allocation and evaluating their time and space complexities
- CO2:** analyze and implement stack and queue data structures by utilizing array representations and evaluating their applications and operational complexities
- CO3:** analyze and implement various types of linked lists by utilizing dynamic memory allocation techniques and evaluating their operational complexities
- CO4:** develop various sorting algorithms, analyze their time complexities, and apply hashing techniques with collision resolution methods, comparing their efficiencies

*(based on psychomotor skills acquired from laboratory component)*

- CO5:** develop and test basic data structures and array operations, including dynamic memory allocation to evaluate their performance and complexity
- CO6:** apply the linear data structures such as stacks and queues and perform various operations using LIFO or FIFO order respectively
- CO7:** solve problems using various linked list representations for efficiently storing and retrieving the data

**CO8:** apply different sorting techniques on unsorted data and sort them in an order, able to store the data using hashing techniques to retrieve the data very effectively

| Course Articulation Matrix (CAM): |            |      |      |      | U24EC204 DATA STRUCTURES THROUGH C |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                               | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC204.1 | 2    | 2    | 2    | 1                                  | -    | -    | 1    | 1    | 1    | 1     | 1     | 2     | 1     |
| CO2                               | U24EC204.2 | 2    | 2    | 2    | 2                                  | -    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO3                               | U24EC204.3 | 2    | 2    | 2    | 2                                  | -    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO4                               | U24EC204.4 | 2    | 2    | 2    | 2                                  | -    | -    | 1    | 1    | 1    | 1     | 2     | 2     | 2     |
| CO5                               | U24EC204.5 | 2    | 2    | 2    | 1                                  | -    | -    | 1    | 1    | 1    | -     | 1     | 2     | 1     |
| CO6                               | U24EC204.6 | 2    | 2    | 2    | 2                                  | -    | -    | 1    | 1    | 1    | -     | 2     | 2     | 2     |
| CO7                               | U24EC204.7 | 2    | 2    | 2    | 2                                  | -    | -    | 1    | 1    | 1    | -     | 2     | 2     | 2     |
| CO8                               | U24EC204.8 | 2    | 2    | 2    | 2                                  | -    | -    | 1    | 1    | 1    | -     | 2     | 2     | 2     |
| U24EC204                          |            | 2    | 2    | 2    | 1.75                               | -    | -    | 1    | 1    | 1    | 1     | 1.75  | 2     | 1.75  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |      |                                    |      |      |      |      |      |       |       |       |       |

| ENGLISH COMMUNICATION AND REPORT WRITING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                                |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------|-------|
| Class: B.Tech. II -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           | Branch: Common to all branches |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | U24MH205  | Credits:                       | 2     |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2-0-0-3-5 | CIE:                           | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 36 Hrs    | ESE:                           | 40%   |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> basic grammar principles, reading speed, forming new words, making coherent paragraphs and also promoting ethical values for meaningful life<br><b>LO2:</b> speaking or writing correct sentences, writing effective letters and improving them self-worth<br><b>LO3:</b> critical reading ability, writing conclusive reports and additionally inculcating positive thinking<br><b>LO4:</b> abridging varieties of lengthy texts and maintaining emotional balance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                                |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                | 9 Hrs |
| <b>GRAMMAR</b> <ul style="list-style-type: none"> <li>Tenses-Structures-usage-examples-exercises for practice</li> <li>Sentence Correction-Correct use of Tenses, Verb forms, Punctuation.</li> </ul> <b>VOCABULARY</b> <ul style="list-style-type: none"> <li>Word formation: Prefixes-Suffixes-Sentence Formation with newly formed words</li> </ul> <b>READINGS SKILL</b> <ul style="list-style-type: none"> <li>Definition-Subskills of Reading-Emphasis on Skimming-Purpose-How to skim through the text-Examples, Exercises for practice</li> </ul> <b>WRITING PRACTICES</b> <ul style="list-style-type: none"> <li>Paragraph Writing-Definition-Organizing Principles of paragraphs-Making a paragraph through hints/ graphs and pictures-Coherence-Linking Devices-Systematic Development of Ideas</li> <li>Paraphrasing-Précising lengthy expressions for clarity and brevity</li> </ul> <b>LIFE SKILLS:</b> Ethical Values and Humanity<br>The Last Leaf: A Short Story by O. Henry<br><i>Self-Learning Topics (SLTs):</i><br>Articles-(Text 2, Unit-II), English Vocabulary (Text 2, Unit-I, Unit-II, Unit-III)<br>Verb Forms (Reference book 1, Topic: 31), Tenses (Reference book 1, Topics: 16, 17, 18, 19)<br>Reported Speech (Reference book 2, Exercises for Practice, Topics: 161-167) |           |                                |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                                | 9 Hrs |
| <b>GRAMMAR</b> <ul style="list-style-type: none"> <li>Tenses-Revision-Exercises for practice</li> <li>Subject-Verb Agreement</li> <li>Reported Speech-Transformation</li> <li>Sentence Correction-Emphasis Concord, Report Speech, Sentence Structures</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |                                |       |

**VOCABULARY**

- Synonyms-Antonyms-Single Word Substitutes-Popular Abbreviations

**READING STRATEGY**

- Emphasis on Scanning the Text-Purpose-Advantages-Examples, Exercises and Practice through Teamwork

**WRITING PRACTICES**

- Letter Writing-Effective Letter Writing Techniques-Information Seeking Letters-Job Application Letters- Apology Letters-Explanation to Memos- E-mails-Cover Letters-Resume

**LIFE SKILLS: Determination**

- How I Became a Public Speaker: A Essay by George Bernard Shaw

*Self-Learning Topics (SLTs): English Vocabulary (Text 2, Unit-I, Unit-II, Unit-III), Tenses (Reference book 3, Topic-30, Exercises, 30.1, 30.2, 30.3)*

**UNIT-III****9 Hrs****GRAMMAR**

- Tenses-Revision-Exercises for Practice
- Nouns-Prepositions-Adverbs-Adjectives
- Sentence Correction: Correct Use of tenses, nouns, prepositions, adverbs and adjectives

**VOCABULARY**

- Phrasal Verbs-Technical Words-Latin Words

**READING STRATEGY**

- Intensive Reading-purpose-Types of Comprehension Questions-Examples, Exercises and Practice through Teamwork

**WRITING PRACTICES**

- Report Writing-Definition-Purpose-Qualities of a Good Report-Formal and Informal Reports-Report Format-Sample Reports-Exercises
- Emphasis on Technical Reports

**LIFE SKILLS: Positive Attitude**

- Be the Best of Whatever You Are: A Poem by Douglas Malloch

*Self-Learning Topics (SLTs): Part of Speech (Textbook 1, Unit-I), Tenses (Reference book 1, Topics-16, 17, 18, 19) Phrasal Verbs (Reference book 3)*

**UNIT-IV****9 Hrs****GRAMMAR**

- Tenses-Revision-Exercises for Practice
- Clauses-Conjunctions-Transformation of Sentences
- Sentence Correction (Based on Part of Speech)-Clauses-Tenses

**VOCABULARY**

- Appropriate Use of Words in Communication-Commonly Confused Words

**ACTIVE READING and NOTE-MAKING**

- Note-Making-Definition-Purpose-Effectiveness

**WRITING PRACTICES**

- Précis Writing-Definition-Purpose-Uses-Examples and Exercises-Practice through Teamwork

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Preparing Statement of Purpose (SoP)</li> </ul> <p><b>LIFE SKILLS:</b> Emotional Balance A Poison Tree: Poem by William Blake</p> <p><b>Self-Learning Topics (SLTs):</b> Tenses (Reference book 2, Topics: 152-157)</p>                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p><b>Course Learning Outcomes (COs):</b><br/> After completion of this course, the student should be able to...</p> <p><b>CO1:</b> apply basic grammar principles in speech and writing, read fast, form new words, make coherent paragraphs and adapt the real value of life</p> <p><b>CO2:</b> create effective letters, e-mails, reply to Memos and do the given tasks with confidence</p> <p><b>CO3:</b> analyze the given texts and write clear and unambiguous reports</p> <p><b>CO4:</b> deduct the superfluous information from lengthy text, prepare SoP (Statement of Purpose) effectively and solve critical problems in life with emotional balance</p> |
| <p><b>Text Book(s):</b></p> <ol style="list-style-type: none"> <li>Sanjay Kumar &amp; Pushp Lata, <i>English Language and Communication Skills for Engineers</i>, 1st ed. As per the latest AICTE syllabus, Oxford University Press, 2018.</li> <li><i>Language and Life: A Skill's Approach</i>, 2nd ed. Based on the latest AICTE model curriculum Orient Blackswan Private Limited 2019.</li> </ol>                                                                                                                                                                                                                                                               |
| <p><b>Reference Book(s):</b></p> <ol style="list-style-type: none"> <li>Thomson A.J., Martinet A.V., <i>A Practical English Grammar</i>, 3rd ed. Oxford University Press, 1997</li> <li>Thomson A.J., Martinet A.V., <i>A Practical English Grammar</i>, 3rd ed. Exercise 2, Oxford University Press, 1997</li> <li>Standard Allen W., <i>Living English Structure</i>, 5th ed. Pearson India Education Pvt Ltd. 2009</li> </ol>                                                                                                                                                                                                                                     |
| <p><b>Web and Video link(s):</b></p> <ol style="list-style-type: none"> <li><a href="https://onlinecourses.nptel.ac.in/noc20_hs56/preview">https://onlinecourses.nptel.ac.in/noc20_hs56/preview</a> Technical English for Engineers by Aisha Icbal, IIT madras.</li> <li><a href="https://onlinecourses.swayam2.ac.in/cec21_lg13/preview">https://onlinecourses.swayam2.ac.in/cec21_lg13/preview</a> Indian Writing in English by Dr. Bindu Ann Philip, St Mary's College Trissur</li> </ol>                                                                                                                                                                         |

| Course Articulation Matrix (CAM): |            |      | U24MH205 ENGLISH COMMUNICATION & REPORT WRITING |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|-------------------------------------------------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2                                            | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24MH205.1 | -    | -                                               | -    | -    | -    | 1    | 2    | 2    | 2    | -     | 2     | 1     | -     |
| CO2                               | U24MH205.2 | -    | -                                               | -    | -    | -    | 1    | 2    | 2    | 2    | -     | 2     | 1     | -     |
| CO3                               | U24MH205.3 | -    | -                                               | -    | -    | -    | 1    | 2    | 2    | 2    | -     | 2     | 1     | -     |
| CO4                               | U24MH205.4 | -    | -                                               | -    | -    | -    | 1    | 2    | 2    | 2    | -     | 2     | 1     | -     |
|                                   | U24MH205   | -    | -                                               | -    | -    | -    | 1    | 2    | 2    | 2    | -     | 2     | 1     | -     |
| 3-HIGH, 2-MEDIUM, 1-LOW           |            |      |                                                 |      |      |      |      |      |      |      |       |       |       |       |

| SPORTS and YOGA                                                                                                                                                                                                              |                  |                                       |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------|------------|
| <b>Class:</b> B. Tech.II-Semester                                                                                                                                                                                            |                  | <b>Branch:</b> Common to all branches |            |
| <b>Course Code:</b>                                                                                                                                                                                                          | <b>U24VA206</b>  | <b>Credits:</b>                       | <b>1</b>   |
| <b>Hours/Week(L-T-P-O-E):</b>                                                                                                                                                                                                | <b>0-0-2-2-4</b> | <b>CIE:</b>                           | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                       | <b>24Hrs</b>     | <b>ESE:</b>                           | <b>40%</b> |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in/on...</i><br>LO1: Yoga and its benefits<br>LO2: various sports & games<br>LO3: sportsman spirit<br>LO4: all round development |                  |                                       |            |

| Sports and Games                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>List of Sports and Games</b><br><div> <div>1. Badminton</div> <div>2. Basket Ball</div> <div>3. Chess</div> <div>4. Carrom</div> <div>5. Foot Ball</div> <div>6. Table Tennis</div> <div>7. Volley Ball</div> <div>8. Cricket</div> <div>9. Hand Ball</div> <div>10. Kabaddi</div> <div>11. Kho-Kho</div> <div>12. Yoga Aasanas</div> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| <b><u>TextBook(s):</u></b><br>1. B.K.Chaturvedi, <i>Rules and Skills of Games and Sports</i> , Publisher – Goodwill Publishing House, B-9, Rattan Jyoti, 18 Rajendra Place, New Delhi.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <b><u>ReferenceBook(s):</u></b><br>1. Dr. Sakure Girish Madhaorao, <i>Foundation of Physical Education and Sports</i> , Sports Publication, New Delhi.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <b><u>Web and Video link(s):</u></b><br>1. Badminton game Video Link:<br><a href="https://www.youtube.com/watch?v=HucIqi8Lw3E&amp;t=22s">https://www.youtube.com/watch?v=HucIqi8Lw3E&amp;t=22s</a><br>2. Basket Ball game Video Link:<br><a href="https://www.youtube.com/watch?v=-tkE2IJoR58">https://www.youtube.com/watch?v=-tkE2IJoR58</a><br>3. Chess Video Link:<br><a href="https://www.youtube.com/watch?v=mDw7lgM8ePo">https://www.youtube.com/watch?v=mDw7lgM8ePo</a><br>4. Carrom game Video Link:<br><a href="https://www.youtube.com/watch?v=z8vvJpNceeg">https://www.youtube.com/watch?v=z8vvJpNceeg</a><br>5. Football game Video Link:<br><a href="https://www.youtube.com/watch?v=mXjW78AgGu4">https://www.youtube.com/watch?v=mXjW78AgGu4</a><br>6. Table Tennis game Video Link:<br><a href="https://www.youtube.com/watch?v=bLrJGWvWI4U">https://www.youtube.com/watch?v=bLrJGWvWI4U</a> |  |

7. Volleyball game Video Link:

<https://www.youtube.com/watch?v=BJJb3-O0Q1U>

8. Cricket game Video Link:

[https://www.youtube.com/watch?v=87hO\\_Vs3-wQ](https://www.youtube.com/watch?v=87hO_Vs3-wQ)

9. Handball game Video Link:

[https://www.youtube.com/watch?v=VCa\\_0USaq8k](https://www.youtube.com/watch?v=VCa_0USaq8k)

10. Kabaddi game Video Link:

<https://www.youtube.com/watch?v=ai1m7ARNyNI>

11. Kho-Kho game Video Link:

[https://www.youtube.com/watch?v=P3\\_z3LKdLdg](https://www.youtube.com/watch?v=P3_z3LKdLdg)

12. Yoga Asanas Video Link:

<https://www.youtube.com/watch?v=e0Q88DUOXjk>

<https://www.youtube.com/watch?v=JoDKbXEUrvQ>

#### Course Learning Outcomes (COs):

After completion of this course, the student should be able to ...

**CO1:** demonstrate physical fitness by performing Yoga asanas

**CO2:** demonstrate physical fitness through various games & sports events with defined benchmarks

**CO3:** demonstrate Sportsman spirit and ethics

**CO4:** demonstrate Physical, Psychological, Social and Emotional balance

| Course Articulation Matrix (CAM): |            |      |      | U24VA206 SPORTS AND YOGA |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|--------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                     | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24VA206.1 | -    | -    | -                        | -    | -    | -    | -    | -    | -    | -     | 1     | -     | -     |
| CO2                               | U24VA206.2 | -    | -    | -                        | -    | -    | -    | -    | 1    | -    | -     | -     | -     | -     |
| CO3                               | U24VA206.3 | -    | -    | -                        | -    | -    | -    | 2    | -    | -    | -     | -     | -     | -     |
| CO4                               | U24VA206.4 | -    | -    | -                        | -    | -    | -    | -    | -    | 1    | -     | 1     | -     | -     |
| U24VA206                          |            | -    | -    | -                        | -    | -    | -    | 2    | 1    | 1    | -     | 1     | -     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                          |      |      |      |      |      |      |       |       |       |       |

## ENGINEERING GRAPHICS THROUGH CAD

|                                        |                  |                                               |              |
|----------------------------------------|------------------|-----------------------------------------------|--------------|
| <b>Class:</b> B.Tech. II –Semester     |                  | <b>Branch:</b> Common to all (except CE & ME) |              |
| <b>Course Code:</b>                    | <b>U24ME207</b>  | <b>Credits:</b>                               | <b>1</b>     |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>0-0-2-2-4</b> | <b>CIE:</b>                                   | <b>100 %</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36Hrs</b>     | <b>ESE:</b>                                   | <b>-</b>     |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

LO1: AutoCAD commands, projections of points and straight line inclined to one plane

LO2: projections of oblique planes

LO3: projections of solids and sections of solids

LO4: conversion of isometric, orthographic projections and simple circuits diagrams

### LABORATORY COMPONENT

#### List of Experiments

1. Importance of Engineering Drawing, principles of engineering drawing, dimensioning; introduction to AutoCAD software-GUI, settings, standard toolbar, toolbars - draw, modify, dimension, properties, design center and tool palettes
2. Introduction to orthographic projections-Vertical Plane, Horizontal plane; Views-Front view, Top view, and Side view and draw the Projection of points in different quadrants
3. Draw the Projection of straight lines
4. Draw the Projection of planes
5. Draw the Projection of solids- Simple position (Axis perpendicular to HP or VP)
6. Draw the projections of solids inclined to both the planes
7. Draw the Sections of solids
8. Draw the Orthographic projections of given objects
9. Conversion of isometric view to orthographic projections
10. Draw the Isometric view from the given orthographic views
11. Draw the pictorial view (3D) from the given Isometric view
12. AutoCAD application in Electrical and Electronics circuits

### TextBook(s):

1. Bhatt N.D., *Elementary Engineering Drawing*, Charotar Publishing House, Anand, India, 2017
2. Kulkarni D. M., Rastogi A. P., and Sarkar A., *Engineering Graphics with AutoCAD*, PHI publisher, revised edition, July 2010

### Reference Book(s):

1. Dhananjay A Jolhe, *Engineering Drawing*, Tata Mc Graw- Hill, 2008
2. Venugopal K. *Engineering Graphics with Auto CAD*, New Age International Publishers Ltd., Hyderabad, 2012
3. Luzadder W.J and DuffJ.M, *Fundamentals of Engineering Drawing*, Prentice-Hall of India, 1995

**Web and Video link(s):**

1. [https://onlinecourses.nptel.ac.in/noc20\\_me79/preview](https://onlinecourses.nptel.ac.in/noc20_me79/preview) NPTEL video link for Engineering drawing and computer graphics By Prof. Rajaram Lakkaraju, IIT Kharagpur.

**Laboratory Manual (for laboratory component):**

1. Engineering Graphics through CAD Laboratory Manual & Record Book, Dept. of ME, KITSW.

**Course Learning Outcomes (COs)**

After completion of this course, the students should be able to...

- CO1:** draw projections of points and straight lines inclined to one plane with Auto CAD.
- CO2:** develop the projections of planes using Auto CAD
- CO3:** construct the projections of solids and sections of solids using Auto CAD
- CO4:** create orthographic and isometric projections and develop the simple electrical and electronic circuit using Auto CAD

| Course Articulation Matrix (CAM): |            |      |      |     | U24ME207 ENGINEERING GRAPHICS THROUGH CAD |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|-----|-------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO3 | PO 4                                      | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24ME207.1 | 2    | 1    | 1   | -                                         | 2    | -    | 1    | -    | 2    | -     | 1     | 1     | 1     |
| CO2                               | U24ME207.2 | 2    | 1    | 1   | -                                         | 2    | -    | 1    | -    | 2    | -     | 1     | 1     | 1     |
| CO3                               | U24ME207.3 | 2    | 1    | 1   | -                                         | 2    | -    | 1    | -    | 2    | -     | 1     | 1     | 1     |
| CO4                               | U24ME207.4 | 2    | 1    | 1   | -                                         | 2    | -    | 1    | -    | 2    | -     | 1     | 1     | 1     |
| U24ME207                          |            | 2    | 1    | 1   | -                                         | 2    | -    | 1    |      | 2    | -     | 1     | 1     | 1     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |            |      |      |     |                                           |      |      |      |      |      |       |       |       |       |

## PRACTICUM - 2

|                                        |                                       |                 |             |
|----------------------------------------|---------------------------------------|-----------------|-------------|
| <b>Class:</b> B.Tech.II semester       | <b>Branch:</b> Common to all branches |                 |             |
| <b>Course Code:</b>                    | <b>U24EL209</b>                       | <b>Credits:</b> | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>0-0-0-4-4</b>                      | <b>CIE:</b>     | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>-</b>                              | <b>ESE:</b>     | <b>-</b>    |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

**LO1:** literature review and identifying research gaps

**LO2:** implementing a project independently by applying knowledge to practice

**LO3:** preparing well-documented report and informative PPT

**LO4:** effective technical presentation and creating video pitch

Practicum is an independent project carried out by the student during the course period, under the supervision of allotted course faculty. It helps to reinforce the students' theoretical knowledge and develop their ability to apply this knowledge to the solution of practical problems. Practicums also prepare them for their MINI and MAJOR PROJECTS and for independent work in their chosen field that promotes creative abilities. Besides they provide Higher Order Cognitive Abilities (HOCAs).

- (i). Practicum is a mandatory semester project work.
- (ii). Practicum is offered as a one credit course. Student has to earn 4 credits (one in each semester from I to IV semesters)
- (iii). Allotment of Practicum topics for students:
  - **Practicum matrix:** In week (-1), the class teacher, in consultation with HoD, shall prepare the practicum matrix of the section. The practicum matrix is the allotment of group of students to the different course faculty of the section, as shown below.

| Course                                 | U24MH201 | J24CY202E | U24EC203 | U24EC204 | J24MH205 | U24VA206 |
|----------------------------------------|----------|-----------|----------|----------|----------|----------|
| Students allotted to different courses | B24XX001 | B24XX011  | B24XX021 | B24XX031 | B24XX041 | B24XX051 |
|                                        | B24XX002 | B24XX012  | B24XX022 | B24XX032 | B24XX042 | B24XX052 |
|                                        | B24XX003 | B24XX013  | B24XX023 | B24XX033 | B24XX043 | B24XX053 |
|                                        | B24XX004 | B24XX014  | B24XX024 | B24XX034 | B24XX044 | B24XX054 |
|                                        | B24XX005 | B24XX015  | B24XX025 | B24XX035 | B24XX045 | B24XX055 |
|                                        | B24XX006 | B24XX016  | B24XX026 | B24XX036 | B24XX046 | B24XX056 |
|                                        | B24XX007 | B24XX017  | B24XX027 | B24XX037 | B24XX047 | B24XX057 |
|                                        | B24XX008 | B24XX018  | B24XX028 | B24XX038 | B24XX048 | B24XX058 |
|                                        | B24XX009 | B24XX019  | B24XX029 | B24XX039 | B24XX049 | B24XX059 |
|                                        | B24XX010 | B24XX020  | B24XX030 | B24XX040 | B24XX050 | B24XX060 |

- In week (-1), the class teacher of a section shall collect 10-12 topics for practicum from each of the course teachers of that section.
- The class teacher, in consultation with HoD shall allot the practicum topics to the students of that section in the following format.

\*\*\*\*

### CIRCULAR

*Allotment of Practicum topics to students*

*Section: .....*

| No. | Roll number<br>of the<br>student | Practicum topic allotted | Practicum<br>under the<br>course | Course<br>faculty |
|-----|----------------------------------|--------------------------|----------------------------------|-------------------|
|     |                                  |                          |                                  |                   |
|     |                                  |                          |                                  |                   |
|     |                                  |                          |                                  |                   |
|     |                                  |                          |                                  |                   |

Note:

1. The students should meet immediately the allotted course faculty for practicum and start working on the practicum with the guidance of course faculty.
2. To complete the Practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and also outside the class work hours during weekdays.
3. The course faculty are advised to guide the allotted students for practicum during the semester course work.

*(Signature of class teacher)*

\*\*\*\*

(iv). *To complete the practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and outside the class work hours during weekdays.*

(v). There shall be only continuous Internal Evaluation (CIE) for practicum for a maximum of 100 marks.

(vi). The practicum course faculty shall evaluate & submit the final marks of the allotted students in week (N+1) to the respective class teacher.

(vii). The class teacher shall collect the final marks of practicum of the students allotted to each course teacher and submit them to the CoE.

viii). Course faculty shall follow his/her own rubrics for practicum evaluation. Focus shall be on knowledge, skills & qualities acquired by the student during the practicum course

(ix). A sample rubric for assessment and evaluation of practicum is as follows:

|                                                               |                  |
|---------------------------------------------------------------|------------------|
| Literature survey & Identification of research gaps           | 10 marks         |
| Working model / process / software package / system developed | 30 marks         |
| Report writing (subjected to max of 30% plagiarism)           | 20 marks         |
| Oral presentation with PPT and viva-voce                      | 20 marks         |
| Video pitch                                                   | 20 marks         |
| <b>Total</b>                                                  | <b>100 marks</b> |

**Note:** It is mandatory for the student to appear for oral presentation and viva-voce to

qualify for course evaluation of Practicum.

- (a) **Practicum Topic:** Each student shall be allotted a topic for practicum by the course faculty member attached to him/her. Interested students can work on their own title for practicum, but with due approval from course faculty.
- (b) **Working Model:** Each student is required to develop a prototype / process / system/simulation model on the given practicum topic and demonstrate/present, during the allotted time, before the course teacher.
- (c) **Report:** Each student is required to submit a well-documented report on the allotted practicum topic as per the format specified by the course faculty. The student shall include answers to the following questions in the report and ppt presentation.
  - What was the objective of the practicum assigned?
  - What are the main responsibilities and tasks for practicum?
  - What knowledge and skills from the coursework are applied in the practicum?
  - What new knowledge and skills are acquired during the practicum?
  - In what ways, can the practicum be helpful for the professional career?
  - What gaps are identified in your practicum work?
  - What improvements or changes you suggest for addressing the identified gaps for future work?
- (d) **Anti-Plagiarism Check:** The practicum report should clear plagiarism check as per the Anti-Plagiarism policy of the institute
- (e) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the course teacher as per the schedule notified by the department
- (f) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her Practicum. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include evidence like videos & pics at the time of implementing the practicum and also key points about his / her business idea / plan (*if any*) and social impact
- (g) The student has to register for the Practicum as a supplementary examination in the following cases:
  - i) he/she is absent for oral presentation and viva-voce
  - ii) he/she fails to submit the report in prescribed format
  - iii) he/she fails to fulfill the requirements of Practicum evaluation as per specified guidelines

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

**CO1:** synthesize literature survey, identify research gaps and define objective & scope of practicum problem

**CO2:** apply knowledge to design & conduct experiments, utilize modern tools for solution of practicum problem and develop working model/ process/ system

**CO3:** demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through practicum

**CO4:** create a video pitch on practicum and make an effective oral presentation using PPTs

| Course Articulation Matrix (CAM): |            |      |      | U24EL209 PRACTICUM-2 |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|----------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EL209.1 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| CO2                               | U24EL209.2 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| CO3                               | U24EL209.3 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| CO4                               | U24EL209.4 | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| U24EL209                          |            | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                      |      |      |      |      |      |      |       |       |       |       |

## SOCIAL EMPOWERMENT ACTIVITY / SELF ACCOMPLISHMENT ACTIVITY(SEA/SAA)- 2

|                                        |                                       |                 |             |
|----------------------------------------|---------------------------------------|-----------------|-------------|
| <b>Class:</b> B.Tech. II semester      | <b>Branch:</b> Common to all branches |                 |             |
| <b>Course Code:</b>                    | <b>U24VA210XXXXX</b>                  | <b>Credits:</b> | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>0-0-0-2-2</b>                      | <b>CIE:</b>     | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>-</b>                              | <b>ESE:</b>     | <b>-</b>    |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

- LO1: holistic development** through activity-based learning to gain real-life experience which effectively help individuals deal appropriately with problems/challenges
- LO2: positive mindset** by actively adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity and handling rejection in life
- LO3: skills for effective fieldwork practice**, which include ethics, observation, communication, interviewing, problem solving, time management, organisation and documentation
- LO4: making a well-documented report and an effective oral presentation** through PPTs portraying knowledge, skills, qualities acquired and social impact of the activity

Activity Based Liberal Learning about Life, Literature and Culture (ABLL@LLC) is introduced for building **generic competencies** in students. ABLL is aimed at all dimensional holistic growth of the learner. The holistic development includes the **physical, emotional, cognitive, spiritual and social aspects**. This is an area which opens the decision-making process, helps the student to develop creativity, an analytical mind, and builds resilience, confidence, hope, well-being and success. This will help student face the world with a greater degree of maturity, stoic and become a wholesome person in the society.

It is more than just learning from books to lead a successful life. These activity-based liberal learning courses, which help students to expand their social roles later in life, are offered under two sequels namely **SEA** (Social Empowerment Activities) and **SAA** (Self Accomplishment Activities)

These SEA/SAA courses also focus on building positive mindset: adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity in your life will help student develop and maintain a positive mindset.

- (a) Each SEA/SAA activity is treated as one credit course
- (b) Student must select one activity per semester, through first 04 semesters, from the courses listed under SEA/ SAA, before commencement of the semester.
- (c) Students are required to earn minimum 04 credits under SEA/SAA, by completing minimum 02 credits through SEA and minimum 02 credits through SAA
- (d) To complete these activities student shall work outside the class work hours, during

weekends, holidays, semester breaks, etc.,

- (e) If a student is not able to attend/ fulfil performance requirements, he/she shall be dropped from the course and shall have to enroll in the forthcoming semesters.

**Monitoring SEA/SAA:**

- (a) **Nodal units:** The Student Activity Centre (SAC) and Centre for Innovation Incubation Research and Entrepreneurship (C-i<sup>2</sup>RE) shall act as nodal units for activities listed under SEA/SAA.

- (b) During the semester period, the student has to **acquire requisite knowledge, conduct fieldwork**, acquire skills and propose unique solutions to the real-life problems

- (c) **Knowledge Acquisition & Skilling:**

- i. Students have to identify goals, acquire and accumulate knowledge on the chosen SEA/SAA activity
- ii. For the activities related to social awareness/issues/challenges that affect society, use the knowledge base, apply relevant skills to analyse the issue and propose unique possible solutions to the social issues/challenges. Practice to acquire necessary skills to seek new opportunities in their personal and professional life.
- iii. For the activities related to physical fitness, music, dance, fine arts, etc., guided practice sessions under supervision of expert/guru are to be planned and executed to acquire the benchmark skills to be demonstrated.

- (d) **Fieldwork:** Fieldwork is an essential component of learning for gaining real-life experiences. In addition to knowledge acquisition & skilling, student has to take up fieldwork on the chosen activity, as part of SEA/SAA course.

- i. This student-driven Fieldwork allow students to interact with the 'real world'. It is an autonomous learning (self-learning) situation that students are more actively involved during the activity and develop a deeper understanding and develop a more positive attitude.
- ii. Fieldwork consists of three phases: preparation, the actual activity and feedback
- iii. **As part of fieldwork, student has to interact with at least two eminent personalities/achievers/renowned persons/inspiring and great personalities related to the activity chosen.**
- iv. Fieldwork will benefit students for any careers where they need to work with communities of people or which involves analysis of complex processes, especially social and cultural.
- v. Certain skills are required for effective fieldwork, which include observation, communication, interviewing, problem solving, documentation, and more
- vi. Other skills important for fieldwork practice include the ability to act in a crisis, to plan, set priorities, mobilize resources, and implement the plan effectively. These skills used in an integrated manner help students solve their problems and to develop one's own leadership style based on the need and culture of the place.

vii. **Eminent personalities/achievers/renowned persons/inspiring and great personalities**

Eminent personalities/ Achievers / Renowned personalities:

(a). **In case of socially relevant problems/ activities of SEA/SAA:** Eminent personalities/ achievers include district administrative officers, Eminent Social workers / NGOs, other inspiring and great personalities

(b). **In case of Sports / Games and Cultural activities of SEA/SAA:** Eminent coaches/ trainers/gurus, achievers who represented/won state level/national level /international level competitions, other inspiring and great personalities.

viii. **For appointment to interact eminent personalities:** Student is expected to follow email etiquette rules and other appropriate polite communication etiquettes for getting appointment and time for interaction

ix. On fieldwork, student is expected to demonstrate solid time management, organizational and note taking skills during fieldwork

x. **Ethics of fieldwork:** Fieldwork is an educational process with commitment to positive values. All fieldwork should be planned and conducted in a way that is ethical, responsible and safe, for people, students, visited communities, if any, and all other stakeholders. Student is expected to maintain integrity and honesty. Avoid bias and deception. Protect the rights and well-being of people involved in fieldwork. The privacy, confidentiality and respect for the eminent people interacted should be maintained and their time, inputs & guidance are to be acknowledged

xi. Student is expected to take care of health and Safety practices for fieldwork and travel

xii. Student should remember that contrary to a *field trip or company visit*, **the emphasis in fieldwork is on acquiring skills**, and not on casually presenting theory and assessing.

xiii. For the fieldwork, student shall go with a scientifically designed questionnaire and record the responses during interaction. These response sheets, along with geo-tagged pic of fieldwork (at the time of interaction & practice sessions, if any) shall be appended as annexures in the report to be submitted for course evaluation.

xiv. **Feedback:** The learnings the student made out of interaction with eminent achievers shall be presented in the report as one of the chapters.

- During feedback, the central focus is on the elaboration of the students' experience during fieldwork. Therefore, the student should create an end product, such as a demonstration/presentation and report in which they demonstrate a link between their experiences during fieldwork and the underlying theoretical concepts and ideas.

(e) **Demonstration / Presentation and Report:** Student after presentation/demonstration of his/her achievements/work, shall get a certificate from the concerned nodal unit

and submit a report, in the prescribed format, to the faculty counsellor for award of grade.

(f) **Flow process for completion of SEA/SAA course:**

- i. **Faculty counsellor approval:** In week (-1), in consultation with faculty counsellor, every student shall, identify minimum of 4 activities listed under SEA/SAA activities, lists their priority and fills the same in ONLINE REGISTRATION FORM FOR SEA/SAA (received in their domain mail id) to Dean, Student Affairs. Dean, Student Affairs shall release the section wise allotment of SEA/SAA courses to students along with the details of supervising faculty of nodal center. The allotment details shall be shared to the SEA/SAA coordinator and the student through domain mail id of the student
- ii. **Identification of goals and preparation of action plan:** In week (1), the respective faculty coordinator(s) of nodal centres shall address the students allotted to them to educate them on fixing goals, plan of action for completion and evaluation. In consultation with nodal centre, based on the workflow of the allotted activity, every student shall identify the goals (of activity) & eminent personalities (to be visited during the field trip) and prepare action plan (oriented workflow) for attaining the identified goals.
- iii. **Field work:** Under the guidance of nodal centre, student shall complete the field work, based on the action plan, with the progress continuously monitored by the faculty counsellor and the nodal centre.
- iv. **Demonstration/ Presentation:** After completion of field work, student shall demonstrate/present his achievements (knowledge/skills gained during the activity) at the nodal centre in the presence of external experts/senior practitioners of the activity. After successful demonstration/presentation, the nodal centre shall provide a certificate of completion indicating that the student has completed the activity in the stipulated time.
- v. **Report writing:** After successful demonstration/presentation, student shall write a 2-3-page report and submit the same to the faculty counsellor. The report shall emphasize knowledge, skills and qualities acquired through the SEA/SAA activities. It shall also include the influence of these activities on enhancing confidence, positive change in life, decision making, transforming choices into desired actions/outcomes.

- (g) **Assessment & Evaluation:** There shall be only *Continuous Internal Evaluation (CIE)* for SEA/SAA. The SEA/SAA activities shall be evaluated at the end of the semester through respective evaluation processes, which shall include field work, presentation/ demonstration, submission of reports on the gathered data/information/ surveys, the details of which have been shown in below table. The department level SEA/SAA coordinator shall collect marks from the nodal centres and faculty counsellors, consolidate them, and submit the final grades to the examination branch, within one week of the last day of instruction. Evaluation of SEA/SAA activities shall be

completed as and when students are ready, but not later than week (N+1).

The CIE for SEA/SAA is as follows:

| Assessment                                     | Maximum marks | Marks to be awarded by |
|------------------------------------------------|---------------|------------------------|
| Goal setting, Planning & Knowledge Acquisition | 20            | Nodal centre           |
| Field work                                     | 40            | Nodal centre           |
| Demonstration/Presentation                     | 20            | Nodal centre           |
| Report submission                              | 20            | Faculty counsellor     |
| <b>Total</b>                                   | <b>100</b>    | <b>-</b>               |

**Note:**

- (a) **Presentation/ Demonstration:** It is mandatory for the student to appear for demonstration and (or) oral presentation oral presentation to qualify for course evaluation. In case of presentation, student should prepare PPT with informative slides including the geo tagged photos of his/her field trips/interactions as per the schedule notified by the nodal centre. In case of demonstration, student must take timeslot from the nodal centre and demonstrate the skills learnt/improved during the allotted timeslot.
  - The necessary arrangements for demonstration shall be looked after the student in consultation with the coordinator with due permission from Head of the department.
- (b) **Report:** Each student is required to submit a well-documented report on the chosen SEA/SAA topic as per the format specified by *department level SEA/SAA coordinator*.
- (c) **Anti-Plagiarism Check:** The SEA/SAA report should clear plagiarism check as per the Anti-Plagiarism policy of the institute.
- (d) **Requirements for passing the course:** A student is deemed to have passed SEA/SAA if he/she
  - a. successfully demonstrates/presents the skills attained at the end of course as per the schedule notified by the nodal centre, **and**
  - b. scores a minimum of 40 marks in the CIE of the course
- (e) **Supplementary examination:** If a student fails in SEA/SAA activity of a particular semester, he must complete the same by enrolling it in the next higher semesters.

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

**CO1:** integrate the five dimensions of physical, emotional, cognitive, spiritual and social aspects in life for holistic development and demonstrate social sensibility

**CO2:** interact effectively through written, oral and nonverbal communication with external-world in a professional, sensitive and culturally relevant manner

**CO3:** analyse the issues related to social empowerment / self-accomplishment, demonstrate problem-solving skills, articulate solutions and demonstrate social sensibility

**CO4:** demonstrate the generic competencies in making a well-documented report and an effective oral presentation with PPTs portraying knowledge, skills, qualities acquired through fieldwork/practice sessions and social impact of the course learning

**Text / Reference Book(s):**

*For knowledge acquisition, students shall refer to textbooks and web resources relevant to the course selected. Plan for fieldwork/practice sessions in coordination with SEA/SAA coordinator*

| Course Articulation Matrix (CAM): |                 | U24VA210XXXXX - Courses listed under SEA/ SAA |      |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-----------------|-----------------------------------------------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |                 | PO 1                                          | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24VA210XXXXX.1 | -                                             | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| CO2                               | U24VA210XXXXX.2 | -                                             | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| CO3                               | U24VA210XXXXX.3 | -                                             | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| CO4                               | U24VA210XXXXX.4 | -                                             | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| U24VA 210XXXXX                    |                 | -                                             | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |                 |                                               |      |      |      |      |      |      |      |      |       |       |       |       |

**Course Code: U24VA XXY(SE/SA) ZZZ**

**X** represents semester; **YY** represents SEA/SAA course serial number in that semester; **SE-** represents SEA activity or **SA** - represents SAA activity; **ZZZ** represents activity code from SEA/SAA baskets

Ex: If A student selects a SEA/SAA course as below:

Semester: 1

SEA/SAA course serial number: 09

SEA/SAA category: SEA

course number: 302

The **course code** will be U24VA109SE302

Ex: If A student selects a SEA/SAA course as below:

Semester: 4

SEA/SAA course serial number: 10

SEA/SAA category: SAA

course number: 206

The **course code** will be U24VA410SA206

## EXPERT TALK SERIES - 2

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                       |                 |             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-----------------|-------------|
| <b>Class:</b> B. Tech.II -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Branch:</b> Common to all branches |                 |             |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>U24AE211</b>                       | <b>Credits:</b> | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>0-0-0-1-1</b>                      | <b>CIE:</b>     | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>-</b>                              | <b>ESE:</b>     | <b>-</b>    |
| <b>Course Learning Objectives (LOs):</b><br><br><i>This course will develop students' knowledge in /on...</i><br><br><b>LO1:</b> 21 <sup>st</sup> century skills needed for industry, current industry trends, challenges and innovations<br><b>LO2:</b> latest technology in practice and applying knowledge to solve real-world problems<br><b>LO3:</b> smart work, soft skills, professional etiquette, networking abilities<br><b>LO4:</b> making a well-documented report portraying the knowledge, skills, qualities acquired and the impact of the learning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                       |                 |             |
| <b>In the 21<sup>st</sup> century, for successful career, degree alone won't suffice. Competencies are much more important.</b><br><br>(a) You need to be aware of the real-world problems, industry working style, need to be confident and smart and you also need to know the tricks of the trade.<br>(b) Learning from industry experts with real-world examples, is important to enhance your educational experience.<br>(c) Enhanced graduate employability benefits all stakeholders. To effectively enhance employability and the immediacy of adding value to company/project, it is important that you are aware of what you are learning and its use in the workplace. The cognitive abilities viz., remember, understand, recall, and application of knowledge and other skills acquired in higher education can be maximized if you are clear on the purpose of your developed competencies and how to apply them in a range of complex situations.<br>(d) Graduate employability could be enhanced through fostering lifelong learning, the development of a range of employability-related competencies and increased confidence and capacity in "reflecting on and articulating these capabilities and attributes in a range of recruitment situations". |                                       |                 |             |
| <b>But how would you know all this without venturing into the industry?</b><br><br>(e) The answer is <b>Industry Expert Talk Series (ETS)</b> . Through ETS, we invite industry experts in different fields to deliver talks and interact with students.<br>(f) Through Industry expert talks students get to know so much more that textbooks don't explain.<br>(g) Students have the opportunity to learn from professionals who have achieved success in their                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                       |                 |             |

respective fields. These speakers often share their personal experiences, case studies, and anecdotes, providing students with real-world examples and perspectives that go beyond theoretical concepts.

- (h) Our competency-focused curriculum URR24 is designed to contribute greatly to the nurturing and development of each of these facets among students through ETS courses
- (i) ETS helps students gain improved industry engagement for an easier transition into the workplace, broader career progression opportunities and personal development.
- (j) In URR24 curriculum, Expert talk series (ETS) is offered as a course under **ability enhancement category of courses**.
- (k) Through ETS sessions, students get the chance to interact with industry regularly which helps them focus on the needs and requirements of current industry. This will not only enthuse the students with new ideas but also motivate them to understand what kind of 21<sup>st</sup> century skills are needed in industry and how they need to groom themselves.
- (l) Through ETS sessions, another benefit is that students learn the importance of soft skills like communication, presentation, email etiquettes, corporate grooming and dressing styles. Conversing with successful people is the biggest motivation and students gain in more ways than one through ETS sessions.
- (m) ETS enhances your learning in many ways for global opportunities for your career.
- (n) All in all, learning from industry experts, is a wonderful opportunity for student to getting acquainted with professional etiquette, acquiring professional knowledge, and getting to know the internal workings of an organization.
- (o) Salient features of ETS are hereunder:
  - (i) ETS is offered from I semester to VI semester.
  - (ii) ETS, in any given semester, is treated as one credit course
  - (iii) Students are required to earn six credits (from I to VI semester)
  - (iv) **Head, Centre for i<sup>2</sup>RE** shall be the **institute level ETS coordinator**
  - (v) Under this course, a minimum of 10 expert talks shall be organized in **online/offline mode** by the parent department / Centre for i<sup>2</sup>RE.
  - (vi) Each expert talk shall be for a minimum duration of 45 minutes (*but not exceeding 90 minutes*) followed by **online quiz/test** for 10 marks (10 MCQs/FiBs; *duration: 10-15 mins*), on the contents covered in the expert talk.
  - (vii) **The Head C-i<sup>2</sup>RE** shall share the marks obtained by the students in each of the quizzes / tests to the respective **department ETS coordinators**.
  - (viii) Each student shall attend a minimum of 6 expert talks and attempt the corresponding

quizzes/ tests conducted at the end of the talks.

- (ix) **Report on ETS:** At the end of semester, the student shall submit a well-documented report on the acquired knowledge and skills, in the prescribed format, to the department ETS coordinator.
  - (x) **Evaluation:** There shall be only continuous Internal Evaluation (CIE) for ETS for a maximum of 100 marks
  - (xi) The department ETS coordinator shall, in coordination with institute level ETS coordinator, submit the final scores to the CoE in week (N+1).
- (p) The CIE for ETS is as follows:

*Rubrics for evaluation of ETS*

|                                                                                               |                  |
|-----------------------------------------------------------------------------------------------|------------------|
| Quiz score<br>(Sum of best 6 quiz scores out of 10 quizzes. Each quiz evaluated for 10 marks) | 60 marks         |
| Attendance (out of 10 quizzes)                                                                | 20 marks         |
| Report in prescribed format (max 30% plagiarism)                                              | 20 marks         |
| <b>Total</b>                                                                                  | <b>100 marks</b> |

- i. **Attendance:** Maximum of 20 marks shall be awarded based on the attendance maintained by the student over a maximum of 10 lectures.

$$\text{Marks for attendance} = \frac{\text{Number of expert talks attended fully}}{10} * 20$$

**ii. Supplementary Exam:**

- (a) Student has to register for ETS supplementary examination if he/she scores less than 40 marks in CIE
- (b) The ETS supplementary examination shall be conducted by the parent department, in physical mode, for 100 marks (MCQs/FiBs;duration: 2Hrs) on the content covered in ETS lectures.
- (c) Department ETS coordinator shall, in coordination with the institute level ETS coordinator, conduct the supplementary exam, and submit scores to the CoE
- (d) Exam material/resources for supplementary: Recorded videos of ETS arranged for that semester, which shall be made available on ETS webpage of institute website

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

- CO1:** identify real-world problems, different career paths, industry requirements, emerging job roles, business practices and exploit new opportunities by staying up-to-date with industry knowledge, trends and technology
- CO2:** identify what 21<sup>st</sup> century employability-related skills and professional etiquette are must in a range of recruitment situations, what skills are absent in him/her, and demonstrate skill improvement
- CO3:** interact with experts, exhibit confidence, demonstrate improved communication and networking abilities potentially leading to mentorship opportunities, internships, or even future job prospects
- CO4:** demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through ETS sessions and impact of the expert talks

| Course Articulation Matrix (CAM): |            |      |      | U24AE211EXPERT TALK SERIES - 2 |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|--------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                           | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24AE211.1 | 1    | 1    | 1                              | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| CO2                               | U24AE211.2 | 1    | 1    | 1                              | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| CO3                               | U24AE211.3 | 1    | 1    | 1                              | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| CO4                               | U24AE211.4 | 1    | 1    | 1                              | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| U24AE211                          |            | 1    | 1    | 1                              | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                                |      |      |      |      |      |      |       |       |       |       |

Course code U24AE2YY: *X represents semester, YY represents ETA course serial number*

# 1<sup>st</sup> Year Exit Courses Syllabus

| INDUSTRIAL ELECTRONICS                                                                                                                                                                                                                        |           |             |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-----|
| Class: B.Tech. II –Semester (Exit course)                                                                                                                                                                                                     |           | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                  | U24EC212X | Credits:    | 3   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                       | 2-0-2-0-4 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                               | 32Hrs     | ESE:        | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                             |           |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                        |           |             |     |
| LO1: the operation of SCRs, TRIACs, DIAC, UJTs, power Transistors and their applications                                                                                                                                                      |           |             |     |
| LO2: various sensors, thermocouples, actuators and their applications                                                                                                                                                                         |           |             |     |
| LO3: programmable controllers and their operation                                                                                                                                                                                             |           |             |     |
| LO4: types of robots, i/o signals & circuits for robots                                                                                                                                                                                       |           |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                              |           |             |     |
| UNIT-I                                                                                                                                                                                                                                        |           | 4 Hrs       |     |
| Introduction to Industrial Electronics: Introduction, Relay logic.                                                                                                                                                                            |           |             |     |
| Solid State Devices in Industrial Applications: Introduction, SCRs, TRIACs, DIAC, UJTs, power Transistors and applications.                                                                                                                   |           |             |     |
| UNIT-II                                                                                                                                                                                                                                       |           | 4 Hrs       |     |
| Input transducers and Sensors: Overview, temperature, pressure, flow, density and viscosity, level, position, motion, ph, humidity and gas detection sensors (one example each).<br>Thermocouples, Actuators, servo motor and stepper motors. |           |             |     |
| UNIT-III                                                                                                                                                                                                                                      |           | 4 Hrs       |     |
| Programmable controllers:Overview, programmable controller application, scanning a PLC program, features of the programmable controller, and operation of programmable controllers.                                                           |           |             |     |
| UNIT-IV                                                                                                                                                                                                                                       |           | 4 Hrs       |     |
| Robots and other motion control systems: Types of Robots, types of robot control and programs, basic parts of a robot system, other types of robot actuators, input and output signals & circuits for robots.                                 |           |             |     |
| LABORATORY COMPONENT                                                                                                                                                                                                                          |           |             |     |
| List of Experiments                                                                                                                                                                                                                           |           |             |     |
| 1. V-I characteristics of Silicon Controlled Rectifier (SCR)                                                                                                                                                                                  |           |             |     |
| 2. SCR Applications: AC & DC Power Control Circuit                                                                                                                                                                                            |           |             |     |
| 3. TRIAC Performance Characteristic                                                                                                                                                                                                           |           |             |     |
| 4. V-I characteristics of DIAC                                                                                                                                                                                                                |           |             |     |
| 5. UJT Relaxation Oscillator                                                                                                                                                                                                                  |           |             |     |
| 6. Motion detection using Ultrasonic Sensor                                                                                                                                                                                                   |           |             |     |
| 7. Temperature and Humidity measurement using sensors                                                                                                                                                                                         |           |             |     |
| 8. Controlling a stepper motor                                                                                                                                                                                                                |           |             |     |
| TextBook(s):                                                                                                                                                                                                                                  |           |             |     |
| 1. M.D. Singh and K.B. Kanchandani, <i>Power Electronics</i> , 2nded.McGraw Hill education, New Delhi, 2007                                                                                                                                   |           |             |     |
| 2. Thomas. E. Kissell, <i>Industrial Electronics</i> ,3rd ed. PHI, New Delhi, 2003                                                                                                                                                            |           |             |     |
| Reference Book(s):                                                                                                                                                                                                                            |           |             |     |

1. M.H. Rashid, *Power Electronics*, Prentice Hall of India, New Delhi, 3rd ed. 2012
2. P.S. Bhimbra, *Power Electronics*, Khanna Publishers, New Delhi, 5th ed. 2012
3. P.C. Sen, *Power Electronics*, Tata McGraw Hill, New Delhi, 24th reprint, 2005

**Laboratory Manual (for laboratory component):**

1. *Industrial Electronics laboratory manual and Record Book*, Department of ECE, KITSW

**Course Learning Outcomes (COs)**

*After completion of this course, the students should be able to,*

- CO1:** Analyze the performance characteristics and applications of semiconductor devices such as SCRs, TRIACs, DIACs, UJTs, and power transistors
- CO2:** Explain the principles, functions, and applications of various sensors, thermocouples, and actuators, including servo motors and stepper motors
- CO3:** explain features and operation of programmable controllers
- CO4:** describe robot controls, input-output signals & circuits for robots

*(based on psychomotor skills acquired from laboratory component)*

- CO5:** analyze the V-I characteristics of SCR and TRIAC
- CO6:** evaluate the performance of DIAC
- CO7:** design UJT Relaxation Oscillator
- CO8:** Develop and implement real-time applications using sensors and actuators to solve practical problems in industrial electronics

| Course Articulation Matrix (CAM): |             |      |       |      | U24EC212X INDUSTRIAL ELECTRONICS |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|------|-------|------|----------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1 | PO 2  | PO 3 | PO 4                             | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC212X.1 | 3    | 3     | 3    | 3                                | --   | 2    | --   | --   | --   | --    | 2     | 2     | 1     |
| CO2                               | U24EC212X.2 | 2    | 2     | 2    | 2                                | --   | 2    | --   | --   | --   | --    | 2     | 2     | 1     |
| CO3                               | U24EC212X.3 | 2    | 2     | 2    | 2                                | --   | 2    | --   | --   | --   | --    | 2     | 2     | 1     |
| CO4                               | U24EC212X.4 | 3    | 2     | 3    | 2                                | --   | 2    | --   | --   | --   | --    | 2     | 2     | 1     |
| CO5                               | U24EC212X.5 | 3    | 3     | 3    | 3                                | -    | 2    | -    | 3    | 3    | 2     | 3     | 1     | 2     |
| CO6                               | U24EC212X.6 | 3    | 3     | 3    | 3                                | -    | 2    | -    | 3    | 3    | 2     | 3     | 1     | 2     |
| CO7                               | U24EC212X.7 | 3    | 3     | 3    | 3                                | -    | 2    | -    | 3    | 3    | 2     | 3     | 1     | 2     |
| CO8                               | U24EC212X.8 | 3    | 3     | 3    | 3                                | 3    | 2    | -    | 3    | 3    | 2     | 3     | 3     | 3     |
| U24EC212X                         |             | 2.75 | 2.625 | 2.75 | 2.75                             | 3    | 2    | -    | 3    | 3    | 2     | 2.5   | 1.75  | 1.625 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |       |      |                                  |      |      |      |      |      |       |       |       |       |

| ELECTRONIC MEASURING INSTRUMENTS                                                                                                                                                                                                                                                  |           |             |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-----|
| Class: B.Tech. II –Semester (Exit course)                                                                                                                                                                                                                                         |           | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                      | U24EC213X | Credits:    | 3   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                           | 2-0-2-0-4 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                   | 32Hrs     | ESE:        | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                 |           |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                            |           |             |     |
| LO1:Various measuring systems functioning and metrics for performance analysis                                                                                                                                                                                                    |           |             |     |
| LO2: Operation and working of different electronic instruments such as voltmeters, current meters and CRO                                                                                                                                                                         |           |             |     |
| LO3:Different AC and DC bridges for the measurement of R, L and C                                                                                                                                                                                                                 |           |             |     |
| LO4:Use of various techniques for measurement of different physical parameters using different classes of transducers                                                                                                                                                             |           |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                  |           |             |     |
| UNIT-I                                                                                                                                                                                                                                                                            |           | 4 Hrs       |     |
| Block Schematics of Measuring Systems and Performance Metrics: PerformanceCharacteristics, Static Characteristics, Accuracy, Precision, Resolution, Types of Errors,Gaussian Error, Root Sum Squares formula, Dynamic Characteristics                                             |           |             |     |
| UNIT-II                                                                                                                                                                                                                                                                           |           | 4 Hrs       |     |
| Measuring Instruments: DC Voltmeters, D' Arsonval Movement, DC Current Meters, AC Voltmeters and Current Meters, Multimeters, Meter Protection, Extension of Range, Specifications of Instruments. CRT, Block Schematic of CRO, Time Base Circuits, Lissajous Figures, CRO Probes |           |             |     |
| UNIT-III                                                                                                                                                                                                                                                                          |           | 4 Hrs       |     |
| Bridges: DC Bridge- Wheat Stone Bridge, AC Bridges-measurement of inductance: - Maxwell's bridge, measurement of capacitance: -Schering bridge                                                                                                                                    |           |             |     |
| UNIT-IV                                                                                                                                                                                                                                                                           |           | 4 Hrs       |     |
| Transducers: Classification, Strain Gauges, Force and Displacement Transducers, Resistance Thermometers, LVDT, Thermocouples, Special Resistance Thermometers, Digital Temperature sensing system, Piezoelectric Transducers, Variable Capacitance Transducers                    |           |             |     |
| LABORATORY COMPONENT                                                                                                                                                                                                                                                              |           |             |     |
| List of Experiments                                                                                                                                                                                                                                                               |           |             |     |
| 1. Conversion of PMMC type ammeter to voltmeter                                                                                                                                                                                                                                   |           |             |     |
| 2. Measurement of A.C. voltage using PMMC meter                                                                                                                                                                                                                                   |           |             |     |
| 3. Measurement of frequency & phase using Lissajous patterns in CRO                                                                                                                                                                                                               |           |             |     |
| 4. Measurement of resistance using Wheatstone bridge circuit setup                                                                                                                                                                                                                |           |             |     |
| 5. Measurement of strain using Strain gauge transducer setup                                                                                                                                                                                                                      |           |             |     |
| 6. Measurement of linear displacement using LVDT type inductive Transducer setup                                                                                                                                                                                                  |           |             |     |
| 7. Measurement of temperature using RTD & Thermistor transducer setups                                                                                                                                                                                                            |           |             |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8. Measurement of pressure using Hall transducer setup                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b><u>TextBook(s):</u></b> <ol style="list-style-type: none"> <li>1. A.K.Sawhney, <i>Electrical, Electronic measurement &amp; Instrumentation</i>, Dhanpat Rai &amp; sons, 18th ed. 2012</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b><u>Reference Book(s):</u></b> <ol style="list-style-type: none"> <li>1. David A. Bell, <i>Electronic Instrumentation and Measurements</i>, Oxford Univ. Press, 1997</li> <li>2. A.D. Helbins, W.D. Cooper, <i>Modern Electronic Instrumentation and Measurement Techniques</i>, PHI, 5th ed. 2003</li> <li>3. K. Lal Kishore, <i>Electronic Measurements and Instrumentation</i>, Pearson Education, 2010</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b><u>Web and Video link(s):</u></b> <ol style="list-style-type: none"> <li>1. <a href="https://onlinecourses.nptel.ac.in/noc24_ee117/preview">https://onlinecourses.nptel.ac.in/noc24_ee117/preview</a>; NPTEL Video Lecture on Electrical Measurement and Electronic instruments by Prof. Avishek Chatterjee   IIT Kharagpur</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b><u>Laboratory Manual (for laboratory component):</u></b> <ol style="list-style-type: none"> <li>1. <i>Electronic Measuring Instruments Laboratory manual and Record Book</i>, Department of ECE, KITSW</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i> <p>CO1: analyse the performance characteristics of a measuring system</p> <p>CO2: identify the various electronic instruments based on their specifications for carrying out a particular task of measurement</p> <p>CO3: design bridge circuits for the measurement of unknown R, L and C</p> <p>CO4: measure various physical parameters by appropriately selecting the transducer</p> <p><i>(based on psychomotor skills acquired from laboratory component)</i></p> <p>CO5: demonstrate the use of PMMC meter for conversion of ammeter to voltmeter &amp; for A.C. voltage measurement and determine resistance &amp; frequency using Wheatstone &amp; Wien's bridge circuits</p> <p>CO6: interpret the operation of CRO for measurement of frequency &amp; phase using Lissajous patterns and examine Strain gauge transducer for strain measurement</p> <p>CO7: utilize LVDT &amp; capacitive transducers to measure displacement and examine RTD &amp; thermocouple transducers for temperature measurement</p> <p>CO8: examine Hall transducer for pressure</p> |

| Course Articulation Matrix (CAM): |             |      |      |      | U24EC213X ELECTRONIC MEASURING INSTRUMENTS |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|------|------|------|--------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1 | PO 2 | PO 3 | PO 4                                       | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC213X.1 | 2    | 1    | 1    | 1                                          | -    | -    | -    | -    | -    | -     | 1     | 1     | 2     |
| CO2                               | U24EC213X.2 | 2    | 1    | 1    | 1                                          | -    | -    | -    | -    | -    | -     | 1     | 1     | 2     |
| CO3                               | U24EC213X.3 | 2    | 1    | 1    | 1                                          | -    | -    | -    | -    | -    | -     | 1     | 1     | 2     |
| CO4                               | U24EC213X.4 | 2    | 1    | 1    | 1                                          | -    | -    | -    | -    | -    | -     | 1     | 1     | 2     |
| CO5                               | U24EC213X.5 | 1    | 1    | 1    | -                                          | -    | -    | -    | 1    | 1    | -     | -     | 1     | -     |
| CO6                               | U24EC213X.6 | 1    | 1    | 1    | -                                          | -    | -    | -    | 1    | 1    | -     | 1     | 1     | 1     |
| CO7                               | U24EC213X.7 | 1    | 1    | 1    | -                                          | 1    | -    | -    | 1    | 1    | -     | 1     | 1     | 1     |
| CO8                               | U24EC213X.8 | 1    | 1    | 1    | -                                          | -    | -    | -    | 1    | 1    | -     | 1     | 1     | 1     |
| U24EC213X                         |             | 1.5  | 1    | 1    | 1                                          | 1    | -    | -    | 1    | 1    | -     | 1     | 1     | 1.5   |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |      |      |                                            |      |      |      |      |      |       |       |       |       |

| PCB DESIGN AND FABRICATION                                                                                                                                                                                                                                                                                 |           |             |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-----|
| Class: B.Tech. II –Semester (Exit course)                                                                                                                                                                                                                                                                  |           | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                               | U24EC214X | Credits:    | 3   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                    | 2-0-2-0-4 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                            | 32Hrs     | ESE:        | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                          |           |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                     |           |             |     |
| LO1: Familiarization of the various types of devices/components that may be mounted on PCB                                                                                                                                                                                                                 |           |             |     |
| LO2: PCB layout techniques for optimized component density and power saving.                                                                                                                                                                                                                               |           |             |     |
| LO3: Design and printing of PCB with etching and soldering techniques.                                                                                                                                                                                                                                     |           |             |     |
| LO4: The current trends and scope of the PCB industry.                                                                                                                                                                                                                                                     |           |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                           |           |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                                     |           | 4 Hrs       |     |
| PCB Fundamentals:                                                                                                                                                                                                                                                                                          |           |             |     |
| PCB Advantages, components of PCB, Electronic components, Microprocessors and Microcontrollers, IC's, Surface Mount Devices (SMD). Classification of PCB - single, double, multilayer, and flexible boards, Manufacturing of PCB, PCB standards                                                            |           |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                                    |           | 4 Hrs       |     |
| Schematic & Layout Design:                                                                                                                                                                                                                                                                                 |           |             |     |
| Schematic diagram, General, Mechanical, and Electrical design considerations, Placing and Mounting of components, Conductor spacing, routing guidelines, heat sinks and package density, Net list, creating components for a library, Tracks, Pads, Vias, power plane, grounding.                          |           |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                                   |           | 4 Hrs       |     |
| PCB Design Processes:                                                                                                                                                                                                                                                                                      |           |             |     |
| Design automation, Design Rule Checking; Exporting Drill and Gerber Files; Drills; Footprints and Libraries Adding and Editing Pins, copper-clad laminates materials of copper clad laminates, properties of laminates (electrical & physical), Etching techniques, Lead cutting and Soldering Techniques. |           |             |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                    |           | 4 Hrs       |     |
| PCB Technology:                                                                                                                                                                                                                                                                                            |           |             |     |
| Introduction of PCB prototyping machines, Schematic Entry, PCB Parts creation, Auto Routing, Post Design, Brief overview of various models available, Recent Trends, and environmental concerns in the PCB industry.                                                                                       |           |             |     |
| LABORATORY COMPONENT                                                                                                                                                                                                                                                                                       |           |             |     |
| List of Experiments                                                                                                                                                                                                                                                                                        |           |             |     |
| A. Analog Electronic Circuits                                                                                                                                                                                                                                                                              |           |             |     |
| 1. To study current-Voltage characteristics of a p-n junction diode (forward bias and reverse bias)                                                                                                                                                                                                        |           |             |     |
| 2. Simple circuit to glow an LED.                                                                                                                                                                                                                                                                          |           |             |     |
| 3. Design Half Wave rectifier without Filter                                                                                                                                                                                                                                                               |           |             |     |
| 4. Design Full Wave rectifier without Filter.                                                                                                                                                                                                                                                              |           |             |     |
| 5. Design, fabrication, and testing of a 9 V power supply with Zener regulator                                                                                                                                                                                                                             |           |             |     |

**B. Digital Electronic Circuits**

6. To verify and design AND, OR, NOT and XOR using NAND gates
7. Design a Half adder and Full Adder

**PCB Design Softwares recommended**

1. KiCAD (Open-Source Electronics Design Automation Suite)  
<https://www.kicad.org/>
2. EasyEDA (Online PCB Design Tool) <https://easyeda.com/>
3. PADS - Siemens EDA (PCB Design Software) <https://eda.sw.siemens.com/en-US/pcb/pads/>

**TextBook(s):**

1. Walter C. Bosshart, *Printed Circuit Board – Design & Technology*, TataMcGraw-Hill, 2008.

**Reference Book(s):**

1. R.S. Khandpur, *Printed Circuit Board –Design, Fabrication, Assembly & Testing*, TataMcGraw-Hill, 1<sup>st</sup> edition, 2005.
2. Chris Schroeder, *Printed Circuit Board Design Using Autocad*, Newnes Publisher, 1998.
3. Clyde F. Coombs, Jr, Happy T. Holden, *Printed Circuits Handbook*, McGraw Hill, 6<sup>th</sup> edition, 2016

**Web and Video link(s):**

1. [https://youtube.com/playlist?list=PL\\_UUrUkFMWRXeJ2mKt5jidU5hId4gwY&si=VotSJBjFbp3LWMAV](https://youtube.com/playlist?list=PL_UUrUkFMWRXeJ2mKt5jidU5hId4gwY&si=VotSJBjFbp3LWMAV).

**Laboratory Manual (for laboratory component):**

1. *PCB Design and Fabrication laboratory manual and record book*, Department of ECE, KITSW

**Course Learning Outcomes (COs)**

*After completion of this course, the students should be able to,*

CO1: illustrate the fundamentals of PCB.

CO2: discuss the Schematic and layout techniques of PCB.

CO3: develop the concepts of PCB design automation and design process.

CO4: discuss current trends and scope of PCB industry.

*(based on psychomotor skills acquired from laboratory component)*

CO5: design and test the functionality of rectifiers

CO6: design a LED circuit Zener regulator.

CO7: implement Boolean functions using logic gates.

CO8: design combinational circuits and test the functionality.

| Course Articulation Matrix (CAM): |             | U24EC214XPCB DESIGN AND FABRICATION |      |      |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|-------------------------------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1                                | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC214X.1 | 2                                   | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     | 1     | 1     |
| CO2                               | U24EC214X.2 | 2                                   | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     | 1     | 1     |
| CO3                               | U24EC214X.3 | 2                                   | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     | 1     | 1     |
| CO4                               | U24EC214X.4 | 2                                   | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | 1     | 1     | 1     |
| CO5                               | U24EC214X.5 | 2                                   | 2    | 2    | 1    | 2    | 1    | 1    | 2    | 1    | 2    | 1     | 1     | 1     | 1     |
| CO6                               | U24EC214X.6 | 2                                   | 2    | 2    | 1    | 2    | 1    | -    | 2    | 1    | 2    | 1     | 1     | 1     | 1     |
| CO7                               | U24EC214X.7 | 2                                   | 2    | 2    | 1    | 2    | 1    | -    | 2    | 1    | 2    | 1     | 1     | 1     | 1     |
| CO8                               | U24EC214X.8 | 2                                   | 2    | 2    | 1    | 2    | 1    | 1    | 2    | 1    | 2    | 1     | 1     | 1     | 1     |
| U24EC214X                         |             | 2.5                                 | 2.25 | 2.66 | 1    | 2    | 1    | 1    | 2    | 1    | 2    | 1     | 1     | 1     | 1     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |             |                                     |      |      |      |      |      |      |      |      |      |       |       |       |       |

# 3<sup>rd</sup> Semester Syllabus

### III SEMESTER

| S. No                                                                                                                                                    | Category | Course Code       | Course Title                                             | Lectures / week |   |   |    |    | Credits |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------|----------------------------------------------------------|-----------------|---|---|----|----|---------|
|                                                                                                                                                          |          |                   |                                                          | L               | T | P | O  | E  | C       |
| 1                                                                                                                                                        | BSC      | U24MH301H         | Applied Mathematics (for ECE)                            | 2               | 1 | - | 6  | 9  | 3       |
| 2                                                                                                                                                        | PCC      | U24EC302          | Electronic Circuits Analysis and Design                  | 2               | 1 | 2 | 5  | 10 | 4       |
| 3                                                                                                                                                        | PCC      | U24EC303          | Digital Design                                           | 2               | 1 | 2 | 5  | 10 | 4       |
| 4                                                                                                                                                        | PCC      | U24EC304          | Signals and Systems                                      | 2               | 1 | - | 4  | 7  | 3       |
| 5                                                                                                                                                        | ESC      | U24EC305          | OOP through Java <sup>#</sup>                            | 2               | 1 | 2 | 5  | 10 | 4       |
| 6                                                                                                                                                        | VAC      | U24VA306A         | Quantitative Aptitude and Logical Reasoning <sup>@</sup> | 2               | - | - | 2  | 4  | 2       |
| 7                                                                                                                                                        | SEC      | U24SE307          | Programming Skill Development Lab - 2                    | -               | - | 2 | 2  | 4  | 1       |
| 8                                                                                                                                                        | ELC      | U24EL308          | Practicum-3                                              | -               | - | - | 4  | 4  | 1       |
| 9                                                                                                                                                        | VAC      | U24VA309XX<br>XXX | SEA-3 / SAA -3                                           | -               | - | - | 2  | 2  | 1       |
| 10                                                                                                                                                       | AEC      | U24AE310          | Expert Talk Series-3                                     | -               | - | - | 1  | 1  | 1       |
| Total:                                                                                                                                                   |          |                   |                                                          | 12              | 5 | 8 | 36 | 61 | 24      |
| Summer/ Inter-Sem Mandatory Bridge Courses: 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet) |          |                   |                                                          | -               | - | - | -  | -  | -       |

#### \* Branch Specific Mathematics:

| Branch Specific Mathematics (Pool-4) |             |                                                                                   |
|--------------------------------------|-------------|-----------------------------------------------------------------------------------|
| S. No.                               | Course Code | Course Title                                                                      |
| 1.                                   | U24MH301A   | Numerical and Statistical Methods<br>(for Civil Engineering)                      |
| 2.                                   | U24MH301B   | Applied Mathematics<br>(for Mechanical Engineering)                               |
| 3.                                   | U24MH301C   | Applied Mathematics<br>(for ECIE)                                                 |
| 4.                                   | U24MH301D   | Discrete Mathematics and Probability Statistics<br>(Common to CSE, CSN, CSO & IT) |
| 5.                                   | U24MH301E   | Essential Mathematics and Statistics for Machine learning<br>(for CSM)            |
| 6.                                   | U24MH301F   | Essential Mathematics and Statistics for Data science<br>(for CSD)                |
| 7.                                   | U24MH301G   | Applied Mathematics<br>(for EEE)                                                  |
| 8.                                   | U24MH301H   | Applied Mathematics<br>(for ECE)                                                  |

| <b>APPLIED MATHEMATICS</b> (for ECE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                    |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B.Tech. III -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>U24MH301H</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-O-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>2-1-0-6-9</b> | <b>CIE:</b>        | <b>60 %</b>  |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>36 Hrs</b>    | <b>ESE:</b>        | <b>40 %</b>  |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> Laplace transforms<br><b>LO2:</b> complex integration<br><b>LO3:</b> distribution function, density function and statistical parameters of a random variable<br><b>LO4:</b> multiple random variables and random processes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |                    | <b>9 Hrs</b> |
| <b>Laplace Transforms:</b> Integral transforms, Kernel of a transform, Laplace transform of a function; Laplace Inverse Transform, Existence and uniqueness of Laplace Transforms, S- plane and region of convergence (ROC); Laplace Transform of some commonly used signals-Dirac-delta (impulse) function ,Step ,Ramp ,Parabolic ,Real exponential , Complex exponential Sine & cosine functions, Damped sine & cosine functions, Hyperbolic sine & cosine functions, Damped hyperbolic sine & cosine functions, Rectangular pulse & triangle; Properties of Laplace Transforms- Linearity, First shifting theorem (Frequency shift property),Multiplication by 't' and division by $\frac{1}{t}$ , Laplace transforms of derivatives and integrals, Time scaling property, Time reversal property, Laplace transform of Heaviside unit step function, Second shifting theorem (time shift property), Laplace transform of periodic functions, Convolution theorem.<br><b>Operational Calculus:</b> Transfer functions, Solution of ordinary differential equations with constant coefficients and system of ordinary differential equations with constant coefficients using Laplace transforms, Application of Laplace transforms to the first order and second order systems subjected to impulse, Step, Periodic, Rectangular, Square, Ramp, Triangular and Sinusoidal functions<br><b>Z-Transforms:</b> Some standard z-transforms, Damping rule, Some standard results, Multiplication by 'n', Inverse z-transforms, Convolution theorem, Convergence of z-transforms.<br><b>Self-Learning Topics (SLTs):</b> Transforms of periodic functions [Text : topic 21.5,Solved problem: 21.9,21.10 Practice problems: exercise 21.2 (2,3,4)], Evaluation of integrals by Laplace transforms[Text 1: topic 21.11, Solved problem: 21.16 Practice problems: exercise 21.3 (19)],Additional problems on convolution theorem Text : topic 21.14, Solved problem: 21.26 Practice problems: exercise 21.5 (18,19,20)] |                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                    | <b>9 Hrs</b> |
| <b>Complex Integration:</b> Analytic Functions, Cauchy-Riemann Equations in Cartesian and Polar coordinates. Line integration in complex plane, Integral of a non analytic function, Dependence on path of integration, ML-Inequality, Cauchy's integral theorem, Cauchy's integral formula, Series expansion of complex functions: Taylor's series and Laurent's series, Zeros and singularities, residues, Residue Theorem- Applications of Residue theorem to the properly chosen integrals around a unit circle and semi circle.<br><b>Self-Learning Topics (SLTs):</b> Additional problems on Cauchy's integral formula [Text 1: topic 20.14, Solved problem: 20.22, Practice problems: exercise 20.6 (4)], Additional problems on Taylor's series and Laurent's series [Text 1: topic 20.16, Solved problem: 20.27, 20.29 Practice problems: exercise 20.7 (7)]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  |                    |              |

| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 9 Hrs |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <p><b>Random Variable:</b> Introduction; Random variable concept - Discrete and Continuous random variables; Cumulative Distribution function, Probability density function and their Properties; Binomial, Poisson, Uniform and Gaussian Distribution functions; Conditional distribution function, Conditional density function and their properties.</p> <p><b>Operations on One Random Variable- Expectation:</b> Introduction, Expected Value of a Random Variable, Function of a Random Variable, Conditional expected value, Moments- moments about the origin, central moments, variance and skew.</p> <p><i>Self-Learning Topics (SLTs): Other Distribution and Density Examples [Text 2: topic 2.5], Functions that give moments [Text 2: topics 3.3], Computer generation of one random variable [Text 2: topic 3.5]</i></p>                                                                                                                                                                                                                                                                                                                                              |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 9 Hrs |
| <p><b>Multiple Random Variables:</b> Vector random variables, Joint distribution function – properties Marginal distribution functions, Joint density function – properties, Marginal density functions, Conditional distribution and density function, Statistical independence, Distribution and density of a sum of random Variables, Central Limit Theorem.</p> <p><b>Operations on Multiple Random Variables:</b> Expected value of a function of Random Variables, Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions; Jointly Gaussian Random Variables.</p> <p><b>Random Processes:</b> Random Process Concept – Classification, Distribution and density functions, Concept of stationarity and statistical independence, Poisson random process.</p> <p><i>Self-Learning Topics (SLTs): Additional problems on Transformations of Multiple Random Variables [Text 2: topic 5.4, Linear Transformations of Gaussian Random Variables [Text 2: topic 5.5, Computer generation of one random variable [Text 2: topic 5.6], Additional problems on Random Process, [Text 2: topic 6.8, Practice problems: exercise 6.1-6 and 6.1-7]</i></p> |       |
| <p><b>Course Learning Outcomes (COs):</b><br/> <i>After completion of this course, the students should be able to...</i><br/> <b>CO1:</b>apply Laplace transforms to solve differential equations<br/> <b>CO2:</b>represent a given function in Taylor's and Laurent's series and evaluate integrals using integral theorems<br/> <b>CO3:</b>evaluate various statistical parameters of a random variable<br/> <b>CO4:</b>perform various operations on multiple random variables</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |
| <p><b>TextBook(s):</b></p> <ol style="list-style-type: none"> <li>1. Grewal, B.S., <i>Higher Engineering Mathematics</i>, Khanna Publishers, Delhi, 44th ed. 2017 (Chapters 20, 21, 23).</li> <li>2. Peyton Z. Peebles, <i>Probability, Random Variables and Random Signal Principles</i>, 4th ed. TMH, 2001 (Chapters 2,3,4,5,6)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |

**Reference Book(s):**

1. Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab, *Signals & Systems* Prentice-Hall signal processing series, ISSN 1050-2769
2. Churchill R.V., *Complex Variable and its Applications*, 9th ed. McGraw Hill, New York, 2013
3. R.P. Singh and S.D. Sapre, *Communication Systems Analog and Digital*, 2nd ed. TMH, 2008
4. Randolph Nelson, *Probability, Stochastic process, and Queueing theory* Springer-Verlog
5. Henry Stark and John W. Woods, *Probability and Random Processes with Application to Signal Processing*, 3rd ed. Prentice Hall, 2002
6. Athanasios Papoulis and S. Unnikrishnan Pillai, *Probability, Random Variables and Stochastic Processes*, 4<sup>th</sup> ed. PHI, 2002.

**Web and Video link(s):**

1. <https://www.youtube.com/watch?v=T6jHXD78dBI> :NPTEL Video Lecture on Complex Integration/Dr.T. Srivastava /Department of Mathes, IIT Roorkee
2. <https://archive.nptel.ac.in/courses/111/102/111102111/>:NPTEL Video Lecture on Probability Theory and Stochastic Processes ./Prof. S. Raja / IIT Delhi

| Course Articulation Matrix (CAM): |             |      |      |      | U24MH301H APPLIED MATHEMATICS (for ECE) |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|------|------|------|-----------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1 | PO 2 | PO 3 | PO 4                                    | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24MH301H.1 | 2    | 2    | 1    | 1                                       | -    | -    | -    | 1    | 1    |       | 1     | 2     | -     |
| CO2                               | U24MH301H.2 | 2    | 2    | 1    | 1                                       | -    | -    | -    | 1    | 1    |       | 1     | 2     | -     |
| CO3                               | U24MH301H.3 | 2    | 2    | 1    | 1                                       | -    | -    | -    | 1    | 1    |       | 1     | 2     | -     |
| CO4                               | U24MH301H.4 | 2    | 2    | 1    | 1                                       | -    | -    | -    | 1    | 1    |       | 1     | 2     | -     |
| U24MH301H                         |             | 2    | 2    | 1    | 1                                       | -    | -    | -    | 1    | 1    |       | 1     | 2     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |      |      |                                         |      |      |      |      |      |       |       |       |       |

| ELECTRONIC CIRCUITS ANALYSIS AND DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                             |            |             |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-----|
| Class: B.Tech. III -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                        |            | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                        | U24EC302   | Credits:    | 4   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                             | 2-1-2-5-10 | CIE :       | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                     | 60 Hrs     | ESE :       | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                                                                                                                                              |            |             |     |
| LO1: biasing and operating point, analysis of transistor at high frequency                                                                                                                                                                                                                                                                                                                                                                                          |            |             |     |
| LO2: analysis of multistage amplifiers and FET at low frequencies                                                                                                                                                                                                                                                                                                                                                                                                   |            |             |     |
| LO3: concept of Positive and Negative feedback and their applications                                                                                                                                                                                                                                                                                                                                                                                               |            |             |     |
| LO4: fundamentals of large signal amplifiers and tuned amplifiers                                                                                                                                                                                                                                                                                                                                                                                                   |            |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            | 9 Hrs       |     |
| High Frequency Transistor Amplifier Circuits: Review of BJT biasing, operating point, small signal analysis of BJT,The Hybrid- $\pi$ (pi) common emitter transistor model, Hybrid- $\pi$ conductances, CE short circuit current gain, High frequency model of a transistor $\alpha$ and $\beta$ cut-off frequencies, Frequency response analysis of single stage amplifier at mid band gain, Gains at low and high frequency, Calculation of gain-bandwidth product |            |             |     |
| Self Learning Topics (SLTs): (Text1: topics 8.1, 8.6, 8.13), Solved problems (Text1: Prob 8.6, Prob 8.14) (Text1: Prob 11.2, 11.4), Practice problems (Text2: Prob 7.8), Evaluation of Expression (Review question page 370-371)                                                                                                                                                                                                                                    |            |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            | 9 Hrs       |     |
| Multistage Amplifiers: Classification of multistage amplifiers based on coupling, RC coupled amplifier, Direct and transformer coupled amplifiers, Cut-off frequencies for $n^{\text{th}}$ stage, Effect of cascading on gain and bandwidth, Darlington pair, Cascode amplifier, Differential amplifiers, Bootstrap amplifier                                                                                                                                       |            |             |     |
| FET Amplifiers: Review - Biasing of FET, FET low frequency models, Low frequency response of amplifier circuits, Analysis of single stage amplifier                                                                                                                                                                                                                                                                                                                 |            |             |     |
| Self Learning Topics (SLTs): (Text1: topics 12.2, 12.3), Solved problems (Text1:sec12.8, Prob 3.5, Prob 3.7), Practice problems (Text2: Prob 11.10)                                                                                                                                                                                                                                                                                                                 |            |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            | 9 Hrs       |     |
| Feedback Amplifiers: Concept of feedback, Classification of feedback amplifiers, General characteristics of negative feedback amplifiers, Effect of negative feedback on amplifier characteristics, Analysis of voltage series, Voltage shunt, Current series and Current shunt Feedback amplifiers                                                                                                                                                                 |            |             |     |
| Oscillators: Conditions for oscillations, RC and LC oscillators, Generalized analysis of LC oscillators, Crystal oscillator, Frequency and amplitude stability of oscillations                                                                                                                                                                                                                                                                                      |            |             |     |
| Self Learning Topics (SLTs): transfer gain in feedback (Text1: topic 13.3), methods of analysis of feedback amplifier (text 1:topic13.7) Solved problems (Text1: sec 13.9, sec 13.10,sec 13.11,13.12), Practice problems (Text2: Prob 12.12)                                                                                                                                                                                                                        |            |             |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            | 9 Hrs       |     |
| Large Signal Amplifiers: Classification, Series fed and transformer coupled Class A, Class B power amplifier, Push-Pull amplifiers and complementary symmetry, Class AB power                                                                                                                                                                                                                                                                                       |            |             |     |

amplifiers, Cross over and harmonic distortion, Heat sinks

**Tuned Amplifiers:** Introduction, Q-factor, Class C tuned amplifiers, Single tuned, Double tuned and Stagger tuned voltage amplifier, Effect of cascading double tuned amplifiers on bandwidth, Stability of tuned amplifiers

**Self Learning Topics (SLTs):** Operations on pointers (Text2: topics 8.1, 8.2,), Solved problems (Text2: Prob 8.5, Prob 8.6, Prob 8.8, Prob 8.9, Prob 8.10), Practice problems (Text2: , Prob 8.9 , Prob 8.13, 8.14, 8.16)

## LABORATORY COMPONENT

### List of Experiments

#### I. Hardware Experiments

1. Design and testing of Common Emitter (CE) amplifier
2. Design and testing of two stage RC coupled amplifier
3. Design and testing of voltage series feedback amplifier
4. Design and testing of RC phase shift oscillator
5. Design and testing of Hartley oscillator
6. Design and testing of Colpit's oscillator
7. Design and testing of single tuned voltage Amplifier
8. Design and testing of Class A power amplifier (with transformer load)
9. Design and testing of Class B complementary symmetry amplifier

#### II. Simulation Based Experiments

1. Design and simulation of Common Emitter (CE) Amplifier
2. Design and simulation of common source amplifier
3. Design and simulation of Two Stage RC coupled amplifier
4. Design and simulation of voltage series feedback amplifier
5. Design and simulation of RC phase shift oscillator
6. Design and simulation of Hartley and Colpit's oscillators
7. Design and simulation of single tuned voltage amplifier
8. Design and simulation of Class A power amplifier (transformer less)
9. Design and simulation of Class B complementary symmetry amplifier

#### TextBook(s):

1. Jacob Millman and C.C.Halkias, *Integrated Electronics*, 2nded. TMH, New Delhi, 1991
2. Donald A Neamen, *Electronic Circuits Analysis and Design*, 3rd ed.Tata McGraw-Hill, 2009

#### Reference Book(s):

1. Robert L.Boylestad, Louis Nashelsky, *Electronic Devices and Circuit Theory*, 9thed.Pearson Education, 2008
2. Sedra, Kenneth, Smith, *Microelectric circuits*, 5thed.Oxford University Press, 2011
3. Mohammad H. Rashid, *Electronic Circuit and Applications*, CENGAGE Learning

#### Web and Video link(s):

1. <https://archive.nptel.ac.in/courses/108/102/108102095/>; NPTEL Video Lecture on analog and digital electronics by Prof. S.C Dattu Roy Basu, Professor of ECE, IIT Delhi.

**Laboratory Manual (for laboratory component):**

1. ELECTRONIC CIRCUITS ANALYSIS AND DESIGN *Laboratory Manual*, Department of ECE, KITSW.

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

**CO1:**analyse the given circuit by drawing relevant h-parameter, hybrid- $\pi$  equivalents and design single stage BJT amplifier for given specification

**CO2:** analyse the frequency response of multistage transistor amplifiers and FET amplifiers at low frequencies.

**CO3:** design the negative feedback amplifiers and oscillator circuits

**CO4:** evaluate the efficiencies of large signal amplifiers and calculate the Q-factor various tuned amplifiers

*(based on psychomotor skills acquired from laboratory component)*

**CO5 :**analyze the frequency response of single stage and multistage amplifiers

**CO6 :**design and test the functionality of BJT amplifiers and oscillators

**CO7 :**design and test single tuned amplifier

**CO8 :**design and test efficiency and distortions present in power amplifiers

| Course Articulation Matrix (CAM): |            |      |      | U24EC302 ELECTRONIC CIRCUITS ANALYSIS AND DESIGN |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|--------------------------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                                             | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC302.1 | 3    | 2    | 2                                                | 1    | 1    | 1    | 1    | 1    | 1    | --    | 2     | 3     | 2     |
| CO2                               | U24EC302.2 | 2    | 3    | 3                                                | 1    | 1    | 1    | 1    | 1    | 1    | --    | 2     | 3     | 2     |
| CO3                               | U24EC302.3 | 2    | 2    | 3                                                | 1    | 1    | 1    | 1    | 1    | 1    | --    | 2     | 3     | 2     |
| CO4                               | U24EC302.4 | 2    | 3    | 3                                                | 1    | 1    | 2    | 1    | 1    | 1    | --    | 2     | 3     | 2     |
| CO5                               | U24EC302.5 | 3    | 2    | 2                                                | 1    | 2    | 1    | 1    | 2    | 2    | 1     | 2     | 3     | 2     |
| CO6                               | U24EC302.6 | 2    | 3    | 3                                                | 1    | 2    | 2    | 1    | 2    | 2    | 1     | 2     | 3     | 2     |
| CO7                               | U24EC302.7 | 2    | 2    | 3                                                | 1    | 2    | 2    | 1    | 2    | 2    | 1     | 2     | 3     | 2     |
| CO8                               | U24EC302.8 | 2    | 3    | 3                                                | 1    | 2    | 2    | 1    | 2    | 2    | 1     | 2     | 3     | 2     |
| U24EC302                          |            | 2.25 | 2.5  | 2.75                                             | 1    | 1.5  | 1.5  | 1    | 1.5  | 1.5  | 1     | 2     | 3     | 2     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |            |      |      |                                                  |      |      |      |      |      |      |       |       |       |       |

| DIGITAL DESIGN                                                                                                                                                                                                                                                                                                                       |            |             |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-------|
| Class: B.Tech. III -Semester                                                                                                                                                                                                                                                                                                         |            | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                         | U24EC303   | Credits:    | 4     |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                              | 2-1-2-5-10 | CIE :       | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                      | 60 Hrs     | ESE :       | 40%   |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                    |            |             |       |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                               |            |             |       |
| LO1: characteristics of digital ICs and design concepts of various logic families                                                                                                                                                                                                                                                    |            |             |       |
| LO2: classification of memories and programmable logic devices                                                                                                                                                                                                                                                                       |            |             |       |
| LO3: basic terminology in Verilog HDL and gate-level modeling                                                                                                                                                                                                                                                                        |            |             |       |
| LO4: data flow modeling, behavioral modeling, tasks and functions                                                                                                                                                                                                                                                                    |            |             |       |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                     |            |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                               |            |             | 9 Hrs |
| Digital Logic Families: Introduction to digital logic families, Characteristics of digital ICs – speed of operation, Power dissipation, Figure of merit, Fan-out, Current and voltage parameters and noise immunity, RTL, DCTL, DTL, TTL-open collector, Totem pole and tristate output, Schottky TTL, ECL, MOS logic and CMOS logic |            |             |       |
| Self Learning Topics (SLTs): Classification of logic families and digital ICs, characteristics of digital ICs – operating temperature range, power supply requirements and flexibilities available, PL and HTL (Text1: chapter 4)                                                                                                    |            |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                              |            |             | 9 Hrs |
| Memory Devices: Introduction to memory devices, Memory organization and operation, classification of memories, Types of ROM and methods of programming PROM, EPROM and EEPROM, RAM – Types, Read and write operations                                                                                                                |            |             |       |
| Programmable Logic Devices: Introduction to PLDs, Design of ROM as a PLD, PLA, PAL, CPLD and FPGA                                                                                                                                                                                                                                    |            |             |       |
| Self Learning Topics (SLTs): Expanding memory size, flash memory and content addressable memory (Text1: chapter 11)                                                                                                                                                                                                                  |            |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                             |            |             | 9 Hrs |
| Verilog HDL Programming: Evolution of CAD, Typical HDL flow, Top-down vs bottom-up design approaches, Module instantiation and design partitioning, Lexical conventions, Data types, Vectors and arrays, Classification of modeling styles in Verilog HDL                                                                            |            |             |       |
| Gate-Level Modeling: Modeling using basic Verilog gate primitives, Description of and/or and buf/not type gates, Rise, Fall and turn-off delays, Min, Max, and Typical delays                                                                                                                                                        |            |             |       |
| Self Learning Topics (SLTs): Popularity of Verilog HDL (Text2: chapter 1), basic concepts - memories (Text2: chapter 3)                                                                                                                                                                                                              |            |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                              |            |             | 9 Hrs |
| Dataflow Modeling: Continuous assignments, Delay specification, Expressions, Operators, Operands and operator types                                                                                                                                                                                                                  |            |             |       |
| Behavioral Modeling: Structured procedures, Initial and always, Blocking and non blocking statements, Delay control, Generate statement, Event control, Conditional statements, multiway branching, Loops, Sequential and parallel blocks                                                                                            |            |             |       |
| Tasks and Functions: Differences between tasks and functions, Declaration, Invocation                                                                                                                                                                                                                                                |            |             |       |

Automatic tasks and functions

**Self Learning Topics (SLTs):** Generate blocks and generate conditional (Text2: chapter 7) and procedural continuous assignments (Text2: chapter 9)

## LABORATORY COMPONENT

### List of Experiments

#### Part – I : To be performed on Digital IC Trainer board

1. Functional verification of logic gates
2. Implementation and functional verification of adders and subtractors using logic gates
3. Functional verification of 4x1 Multiplexer and 1x4 Demultiplexer
4. Functional verification of Flip-flops
5. Implementation and functional verification of shift registers
6. Implementation and functional verification of Ring counter and Johnson Counter

#### Part – II : To be performed on ECAD tool

7. Implementation of all logic gates using Verilog HDL
8. Implementation of half-adder & full-adder using Verilog HDL
9. Implementation of 4x1 mux and 1x4 de-mux using Verilog HDL
10. Implementation of all flip-flops using Verilog HDL
11. Implementation of 4-bit binary counter (synchronous & asynchronous) using Verilog HDL
12. Implementation of simple ROM and RAM using Verilog HDL

#### TextBook(s):

1. R P. Jain, Kishor Sarawadekar, "Modern Digital Electronics", 5th ed. Mc Graw Hill, 2022
2. Samir Palnitkar, "Verilog HDL–Guide To Digital Design And Synthesis", 3rd ed. Pearson Education, 2003

#### Reference Book(s):

1. M. Moris Mano, M.D.Cillett, "Digital Design", PHI, India, 4th ed. 2006

#### Web and Video link(s):

1. [https://onlinecourses.nptel.ac.in/noc24\\_cs61/preview](https://onlinecourses.nptel.ac.in/noc24_cs61/preview) NPTEL Video Lecture on Digital Design with Verilog by Prof. Chandan Karfa and Prof. Aryabartta Sahu, IIT Guwahati.

#### Laboratory Manual (for laboratory component):

1. Digital Design Laboratory Manual and Record Book, Department of ECE, KITSW

#### **Course Learning Outcomes (COs):**

After completion of this course, the students should be able to...

**CO1:** justify the selection of a logic family for a given application based on Figure of Merit

**CO2:** build a memory system using ROM/RAM hierarchy and propose PLD-based solutions for given constraints

**CO3:** examine the functional violations using gate-level modeling in Verilog HDL

**CO4:** design the Verilog module using generate blocks and automate testbenches for functional verification.

*(based on psychomotor skills acquired from laboratory component)*

CO5: build and test logic gates/adders on IC trainer boards

CO6: develop Verilog code for combinational and sequential circuits

CO7: examine memory functionality through HDL simulation

CO8: design a complete digital system using Verilog HDL

| Course Articulation Matrix (CAM): |            |      |      | U24EC303 DIGITAL DESIGN |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|-------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                    | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC303.1 | 3    | 2    | 1                       | 1    | 1    | 1    | 1    | 1    | 1    | -     | -     | 2     | 1     |
| CO2                               | U24EC303.2 | 3    | 3    | 2                       | 2    | 1    | 1    | 1    | 1    | 1    | -     | -     | 2     | 2     |
| CO3                               | U24EC303.3 | 3    | 3    | 3                       | 1    | 2    | 1    | 1    | 1    | 1    | -     | -     | 2     | 3     |
| CO4                               | U24EC303.4 | 3    | 3    | 3                       | 1    | 3    | 1    | 1    | 1    | 1    | -     | -     | 2     | 3     |
| CO5                               | U24EC303.5 | 1    | 2    | 2                       | 1    | 3    | 1    | 1    | 2    | 2    | -     | -     | 3     | 2     |
| CO6                               | U24EC303.6 | 2    | 3    | 3                       | 1    | 3    | 1    | 1    | 2    | 2    | -     | -     | 3     | 3     |
| CO7                               | U24EC303.7 | 2    | 3    | 3                       | 2    | 3    | 1    | 1    | 2    | 2    | -     | -     | 3     | 3     |
| CO8                               | U24EC303.8 | 2    | 3    | 3                       | 2    | 3    | 1    | 1    | 3    | 2    | -     | -     | 3     | 3     |
| U24EC303                          |            | 2.4  | 2.8  | 2.5                     | 1.4  | 2.4  | 1    | 1    | 2.25 | 1.5  | -     | -     | 2.5   | 2.5   |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                         |      |      |      |      |      |      |       |       |       |       |

| SIGNALS AND SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |             |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B.Tech. III -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | U24EC304  | Credits:    | 3     |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 2-1-0-4-7 | CIE :       | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 36 Hrs    | ESE :       | 40%   |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> continuous-time (CT) and discrete-Time (DT) signals and systems and convolution<br><b>LO2:</b> continuous-time Fourier Series and continuous time Fourier transform (CTFT)<br><b>LO3:</b> discrete-time Fourier series(DTFS) and discrete-time Fourier transform (DTFT) and its applications<br><b>LO4:</b> z-Transform, and realizations of IIR systems                                                                                                                                                                                                                               |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |             | 9 Hrs |
| <b>Signals and Systems:</b> Continuous-time (CT) and Discrete-Time (DT) signals, Sampling theorem (statement only), Transformations of independent variable, Exponential and sinusoidal signals, Singularity functions, CT & DT Systems, Basic system properties<br><b>Linear Time-Invariant (LTI) Systems:</b> DT-LTI systems: Convolution sum, CT-LTI systems: Convolution integral<br><b>Self-Learning Topics (SLTs):</b> Text1: Basic Problems 1.3,1.9, 1.21, Text 1: Simple examples of systems (Ex:1.8,1.9), System properties (Ex: 1.14, 1.16, 1.20), Prob: 1.19, 1.28, Properties of LTI systems (Text 1: topic 2.3) ,LTI systems described by differential and difference equations (Text 1:topic 2.4) |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |             | 9 Hrs |
| <b>Continuous-Time Fourier Series (CTFS):</b> Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series, Dirichlet's conditions<br><b>Continuous-Time Fourier Transform (CTFT):</b> CTFT for representation of aperiodic signals, Convergence of Fourier transform-Dirichlet conditions, CTFT for periodic signals; Properties of the CTFT - Convolution property, Multiplication property; Systems characterized by linear constant-coefficient differential equations (LCCDE)<br><b>Self Learning Topics (SLTs):</b> Text 1: Ex:4.12, 4.13, 4.19, 4.26, Ref Text 4: Solved probs: 5.23, 5.25, 5.26                                                                     |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |             | 9 Hrs |
| <b>Discrete-Time Fourier Series (DTFS):</b> Fourier series representation of DT periodic signals, Properties of DTFS<br><b>Discrete-Time Fourier Transform (DTFT):</b> DTFT for aperiodic signals, DTFT for periodic signal, properties for the DTFT, Convolution property, Multiplication property, Systems characterized by linear constant-coefficient difference equations (LCCDE).<br><b>Self Learning Topics (SLTs):</b> Fourier series and LTI systems (Text 1: topic 3.8), ex: 5.3, 5.4, 5.13, Ref Text 4: Solved probs: 6.11, 6.18                                                                                                                                                                     |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |             | 9 Hrs |
| <b>z-Transform:</b> z-transform, Region of convergence (ROC), Inverse z-transform, Properties of z-transform, z-transform of some common signals, Analysis and characterization of LTI system using z-transform                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |             |       |

**Block Diagram Representations:** Structures for IIR systems - Direct form I & Direct form II realizations of IIR systems

**Self Learning Topics (SLTs):** Cascade and parallel form realizations of IIR systems(text 1: Ex 10.30).Ref Text 4: Topic-Review of complex numbers: Appendix C: C.1 Solved prob: 4.3, 4.16

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

**CO1:** Classify CT and DT signals and systems, apply signal transformations, and evaluate LTI system responses using convolution

**CO2:** apply the Continuous-Time Fourier Transform (CTFT) for analyzing aperiodic and periodic signals, and analyze systems described by linear constant-coefficient differential equations

**CO3:** analyze DT signals using Fourier Series and Fourier Transform, apply their properties, and evaluate LCCDE-based systems

**CO4:** represent LTI systems in Z-domain, including system stability, causality, and realize IIR systems using block diagram

**TextBook(s):**

1. Alan V. Oppenheim and Alan S.Willsky with S. Hamid Nawab, "Signals & Systems", PHI, 2nd ed. 2010

**Reference Book(s):**

1. Simon Haykin and Barry Van Veen, "Signals & Systems", 2nd Edition, Wiley India, 2008
2. Mrinal Mandal and Amir Asif, "Continuous and Discrete Time Signals and Systems", Cambridge University Press, 1st Edition, 2008
3. M.J.Roberts and Govind Sharma, "Fundamentals of Signals and Systems", 2nd ed. McGraw Hill, 2010
4. H.P. Hsu, "Signals& Systems", 2nd ed. Schaum's Outlines (McGraw Hill), 2009

**Web and Video link(s):**

1. [https://www.youtube.com/watch?v=879pXoml0XI&list=PLuv3GM6gsE0WgB\\_q3tI2Gat\\_PeJQhF8o&index=1](https://www.youtube.com/watch?v=879pXoml0XI&list=PLuv3GM6gsE0WgB_q3tI2Gat_PeJQhF8o&index=1); NPTEL Video Lecture on Introduction to Signals and Systems, Signal Classification
2. [https://www.youtube.com/watch?v=VDy8nwyKaAw&list=PLuv3GM6gsE0WgB\\_q3tI2Gat\\_PeJQhF8o&index=6](https://www.youtube.com/watch?v=VDy8nwyKaAw&list=PLuv3GM6gsE0WgB_q3tI2Gat_PeJQhF8o&index=6) ;NPTEL Video Lecture on Properties of Linear Systems
3. [https://www.youtube.com/watch?v=Y33shcL7ydE&list=PLuv3GM6gsE0WgB\\_q3tI2Gat\\_PeJQhF8o&index=36](https://www.youtube.com/watch?v=Y33shcL7ydE&list=PLuv3GM6gsE0WgB_q3tI2Gat_PeJQhF8o&index=36) ;NPTEL Video Lecture on Fourier Transform (FT) Introduction
4. [https://www.youtube.com/watch?v=nXDq6K35a\\_k&list=PLuv3GM6gsE0WgB\\_q3tI2Gat\\_PeJQhF8o&index=24](https://www.youtube.com/watch?v=nXDq6K35a_k&list=PLuv3GM6gsE0WgB_q3tI2Gat_PeJQhF8o&index=24);NPTEL Video Lecture on Z-Transform

| Course Articulation Matrix (CAM): |            |      |      | U24EC304 SIGNALS AND SYSTEMS |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                         | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC304.1 | 2    | 2    | 1                            | 1    | --   | 1    | --   | 1    | 1    | 1     | 1     | 1     | 2     |
| CO2                               | U24EC304.2 | 2    | 2    | 1                            | 1    | --   | 1    | --   | 1    | 1    | 1     | 1     | 1     | 2     |
| CO3                               | U24EC304.3 | 2    | 2    | 1                            | 1    | --   | 1    | --   | 1    | 1    | 1     | 1     | 1     | 2     |
| CO4                               | U24EC304.4 | 2    | 2    | 1                            | 1    | --   | 1    | --   | 1    | 1    | 1     | 1     | 1     | 2     |
| U24EC304                          |            | 2    | 2    | 1                            | 1    | --   | 1    | --   | 1    | 1    | 1     | 1     | 1     | 2     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                              |      |      |      |      |      |      |       |       |       |       |

## OBJECT ORIENTED PROGRAMMING THROUGH JAVA

|                                                                                                                                                                                                                                                                                                             |            |             |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-----|
| Class: B.Tech.III –Semester                                                                                                                                                                                                                                                                                 |            | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                | U24EC305   | Credits:    | 4   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                     | 2-1-2-5-10 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                             | 60 Hrs     | ESE:        | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                           |            |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                      |            |             |     |
| LO1: programming paradigms and java programming constructs                                                                                                                                                                                                                                                  |            |             |     |
| LO2: classes, methods and strings                                                                                                                                                                                                                                                                           |            |             |     |
| LO3: inheritance, dynamic method dispatch, interfaces and packages                                                                                                                                                                                                                                          |            |             |     |
| LO4: exception handling,I/O and multi-threading                                                                                                                                                                                                                                                             |            |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                            |            |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                                      |            | 9 Hrs       |     |
| Programming Paradigms: Procedural programming, Modular programming, Object oriented programming (OOP), Generic programming                                                                                                                                                                                  |            |             |     |
| Java Basics:The History and evolution of Java, An overview of java, Data types, Variables and arrays, Operators, Control statements                                                                                                                                                                         |            |             |     |
| Introducing Classes: Class fundamentals, Declaring Objects, Object reference variables, Introducing Methods                                                                                                                                                                                                 |            |             |     |
| Self Learning Topics (SLTs): Lexical Issues like Keywords, identifiers, Literals and comments (TextBook-Chapter 2), Type conversions and casting (TextBook-Chapter 3)                                                                                                                                       |            |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                                     |            | 9 Hrs       |     |
| Classes and Methods: Overloading methods, this keyword, Passing and returning objects, Recursion, Variable length arguments, Constructors, Overloading constructors, Garbage collection, Static variables, Static blocks, Static methods, Nested and inner classes, Command line arguments, Wrapper classes |            |             |     |
| Strings: Exploring String, StringBuffer, StringBuilder and StringTokenizer classes                                                                                                                                                                                                                          |            |             |     |
| Self Learning Topics (SLTs): Overloading Vararg Methods, Varargs and Ambiguity (TextBook-Chapter: 7),Anonymous Inner classes(TextBook-Chapter-25)                                                                                                                                                           |            |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                                    |            | 9 Hrs       |     |
| Inheritance: Inheritance basics, Types of inheritance, Using super, Method overriding, Order of constructors Execution, Dynamic method dispatch, Abstract classes, final with inheritance, Object class                                                                                                     |            |             |     |
| Interfaces: Defining an interface, Implementing interfaces, Nested interfaces, Variables in interfaces, Interfaces can be extended                                                                                                                                                                          |            |             |     |
| Packages:Defining a package, Packages and Member Access, Importing packages                                                                                                                                                                                                                                 |            |             |     |
| Self Learning Topics (SLTs): Accessing Implementations Through Interface References, Default interface methods, Use static Methods in an Interface, private interface methods(TextBook-Chapter-9)                                                                                                           |            |             |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                     |            | 9 Hrs       |     |
| Using I/O: I/O basics, Reading, Writing and copying files using byte and character streams                                                                                                                                                                                                                  |            |             |     |
| Exception Handling: Fundamentals, Exception types, Uncaught exceptions, Using try and catch, Multiple catch clauses, Nested try statements, throw, throws, finally, Creating your own exception sub classes.                                                                                                |            |             |     |

**Multithreading:** Creating a thread, Creating multiple threads, Thread priorities, Synchronization, Interthread communication

**Self Learning Topics (SLTs):** *try-with resource, multi catch, chained exception, precise re-throw (TextBook-Chapter: 10), Serialization- Writing and reading objects to and from the file- (TextBook-Chapter-22)*

## LABORATORY COMPONENT

### List of Experiments

#### Experiment-I:

1. Develop a java program to demonstrate different operators in java
2. Develop a java program to demonstrate control structures
3. Develop a java program to demonstrate *switch* statement

#### Experiment-II:

1. Develop a java program to read an array and display them using *for-each* control. Finally display the sum of array elements
2. Develop a java program to read a matrix and display whether it is an identity matrix or not. Use *civilized form* of *break* statement
3. Develop a java program to define a two-dimensional (2D) array where each row contains different number of columns. Display the 2D-array using *for-each*

#### Experiment-III:

1. Develop a java program to demonstrate class concept
2. Develop a java program to demonstrate *this keyword*
3. Develop a java program to demonstrate object reference variable
4. Develop a java program to demonstrate overloading of methods
5. Develop a java program to demonstrate passing and returning objects

#### Experiment-IV:

1. Develop a java program to demonstrate variable length argument (using array and ellipsis notation)
2. Develop a java program to demonstrate constructors and garbage collection
3. Develop a java program to demonstrate nested and inner classes
4. Develop a java program to demonstrate *static variables, static methods, and static blocks*

#### Experiment-V:

1. Read at least five strings from command line argument and display them in sorted order
2. Develop a java program to demonstrate wrapper class by reading N number of integers from command line and display their sum
3. Develop a java program to demonstrate wrapper class by reading N floating point numbers from command line and display their average

#### Experiment-VI:

1. Develop a java program to accept a string, count number of vowels and remove all vowels
2. Develop a java program to accept a string, count number of vowels and remove all vowels using *StringBuffer* class
3. Develop a java program to accept a line of text, tokenize the line using *StringTokenizer* class and print the tokens in reverse order

**Experiment-VII:**

1. Develop a java program to demonstrate single level-inheritance
2. Develop a java program to demonstrate multilevel inheritance using super
3. Develop a java program to demonstrate method overriding

**Experiment-VIII:**

1. Develop a java program to demonstrate dynamic method dispatch
2. Develop a java program to demonstrate use of abstract class
3. Develop a java program to demonstrate the use of overriding *equals()* method of an Object class

**Experiment-IX:**

1. Develop a java program to implement interfaces
2. Develop a java program to extend the interfaces
3. Develop a java program to demonstrate implementation of nested interfaces

**Experiment-X:**

1. Develop a java program to create a *package* and demonstrate to import the *package* into any java program (Consider the behaviour of all access specifiers)

**Experiment-XI:**

1. Develop a java program to demonstrate *try-catch* block
2. Develop a java program to demonstrate *throw* clause
3. Develop a java program to demonstrate *throws* clause
4. Develop a java program to demonstrate *re-throw* an exception and *finally* block

**Experiment-XII:**

1. Develop a java program to demonstrate read/write/copy a file using *byte stream*
2. Develop a java program to demonstrate read/write/copy a file using *character stream*
3. Develop a java program to create a thread (using *Thread* class or *Runnable* interface)
4. Develop a java program to demonstrate *synchronization* of threads
5. Develop a java program to demonstrate *Inter-thread communication*

**Text Book(s):**

1. Herbert Schildt, *Java The Complete Reference*, 13th ed. New Delhi: McGraw Hill, 2024

**Reference Book(s):**

1. Balaguruswamy, *Programming with Java: A Primer*, 7th ed. New Delhi: McGraw Hill, 2023
2. Kathy Sierra and Bert Bates, *Head First Java*, 2nd ed. Boston: O'Reilly Media, 2005
3. Harvey Deitel and Paul J. Deitel, *Java How to Program*, 11th ed. New Delhi: Pearson, 2018

**Web and Video link(s):**

1. <https://nptel.ac.in/courses/106105191NPTEL> Video Lecture on Java Programming by Prof. Debasis Samanta, Professor of CSE, IIT Kharagpur

**Laboratory Manual (for laboratory component):**

1. *Object Oriented Programming through java Manual and Record Book*, Department of CSE (AI & ML), KITSW

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to,*

**CO1:** analyze the strengths and limitations of various programming paradigms to determine their suitability for solving various programming problems in java

**CO2:** develop java programs using classes, constructors, methods and various string concepts

**CO3:** apply reusability concepts like inheritance, dynamic method dispatch, interfaces and packages to build java programs

**CO4:** develop java programs using I/O, file handling, exception handling and multithreading concepts

*(based on psychomotor skills acquired from laboratory component)*

**CO5:** develop java fundamental programs using operators, control structures and arrays

**CO6:** develop java programs using classes, constructors and various string concepts

**CO7:** build java programs on inheritance, dynamic method dispatch, interfaces and packages

**CO8:** develop java programs using I/O, exception handling and multithreading concepts

| Course Articulation Matrix (CAM): |            |      |      | U24EC305 OBJECT ORIENTED PROGRAMMING THROUGH JAVA |      |      |      |      |      |      |       |       |       |       |  |
|-----------------------------------|------------|------|------|---------------------------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|--|
| CO                                |            | PO 1 | PO 2 | PO 3                                              | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |  |
| CO1                               | U24EC305.1 | 2    | 2    | 2                                                 | -    | 1    | -    | -    | -    | -    | -     | 1     | 1     | 1     |  |
| CO2                               | U24EC305.2 | 2    | 2    | 2                                                 | 1    | 2    | -    | -    | 1    | -    | -     | 1     | 1     | 1     |  |
| CO3                               | U24EC305.3 | 2    | 2    | 3                                                 | 2    | 1    | -    | -    | -    | -    | -     | 1     | 2     | 2     |  |
| CO4                               | U24EC305.4 | 2    | 2    | 3                                                 | 2    | 2    | -    | -    | 1    | -    | -     | 1     | 2     | 2     |  |
| CO5                               | U24EC305.5 | 1    | 1    | 1                                                 | 1    | 1    | -    | -    | 1    | 1    | -     | 1     | 1     | 1     |  |
| CO6                               | U24EC305.6 | 1    | 2    | 2                                                 | 2    | 2    | -    | -    | 1    | 1    | -     | 1     | 1     | 1     |  |
| CO7                               | U24EC305.7 | 1    | 2    | 3                                                 | 2    | 2    | -    | -    | 1    | 1    | -     | 1     | 2     | 2     |  |
| CO8                               | U24EC305.8 | 1    | 2    | 3                                                 | 2    | 2    | -    | -    | 1    | 1    | -     | 1     | 2     | 2     |  |
| U24EC305                          |            | 1.5  | 1.5  | 1.87                                              | 2.37 | 1.5  | 1.62 | -    | -    | 1    | -     | 1     | 1.5   | 1.5   |  |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |            |      |      |                                                   |      |      |      |      |      |      |       |       |       |       |  |

| QUANTITATIVE APTITUDE AND LOGICAL REASONING                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                                |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------------------|------|
| Class: B.Tech.III -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           | Branch: Common to all Branches |      |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | U24VA306A | Credits:                       | 2    |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2-0-0-2-4 | CIE                            | 60 % |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 24Hrs     | ESE                            | 40 % |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |                                |      |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                                |      |
| LO1: quantitative aptitude &problem-solving skills                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                                |      |
| LO2: computation of abstract quantitative information                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |                                |      |
| LO3:application of basic mathematics skills & critical thinking to draw conclusions                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                |      |
| LO4: evaluation of validity & possible biases in arguments presented in authentic contexts                                                                                                                                                                                                                                                                                                                                                                                                     |           |                                |      |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           | 6Hrs                           |      |
| Quantitative Aptitude-I: Number system, Averages, Percentages, Ratios & proportions, Time, Speed & distance, Time and work                                                                                                                                                                                                                                                                                                                                                                     |           |                                |      |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           | 6Hrs                           |      |
| Quantitative Aptitude-II: Simple interest, Compound interest, Profit & loss, Ages, Permutations &Combinations, Probability                                                                                                                                                                                                                                                                                                                                                                     |           |                                |      |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           | 6Hrs                           |      |
| Logical Reasoning-I: Series completion, Analogy, Coding and decoding, Blood relations, Number, Ranking & Time sequence test, Linear & Circular arrangements                                                                                                                                                                                                                                                                                                                                    |           |                                |      |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           | 6Hrs                           |      |
| Logical Reasoning-II: Data sufficiency, Logical Venn diagram, Syllogisms, Statement & Arguments, Statement & Assumptions, Direction sense test                                                                                                                                                                                                                                                                                                                                                 |           |                                |      |
| Course Learning Outcomes (COs):                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                |      |
| After completion of this course, the students should be able to...                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                                |      |
| CO1: apply arithmetic concepts such as averages, percentages, ratios, and time-based calculations to solve real-life quantitative problems                                                                                                                                                                                                                                                                                                                                                     |           |                                |      |
| CO2: analyze and solve problems involving financial, arithmetic and probability using structured quantitative methods                                                                                                                                                                                                                                                                                                                                                                          |           |                                |      |
| CO3: identify patterns and apply deductive reasoning to solve series, coding-decoding, and arrangement-based logical problems                                                                                                                                                                                                                                                                                                                                                                  |           |                                |      |
| CO4: evaluate logical statements, assess validity, and draw conclusions using tools like syllogisms, Venn diagrams, and argument analysis                                                                                                                                                                                                                                                                                                                                                      |           |                                |      |
| Note: Students should go through the QALR course supplementary material made available on online learning platform                                                                                                                                                                                                                                                                                                                                                                             |           |                                |      |
| <ul style="list-style-type: none"><li>Contents covered in class shall be practiced through the material available on the online learning platform. At home practice problems and practice tests shall be made available on the online learning platform</li><li>Tutorial classes shall be conducted on the online learning platform and hence students shall attend the tutorial classes with laptop/tab</li><li>All assessments shall be conducted through online learning platform</li></ul> |           |                                |      |
| TextBook(s):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                |      |
| 1. R S Agarwal, Quantitative Aptitude for Competitive Examinations, 3rd ed., New Delhi: S                                                                                                                                                                                                                                                                                                                                                                                                      |           |                                |      |

- Chand Publications, 2019. (Chapters 1,6,7,8,10,11,12,15,17,21,22,30,31 - for Unit I & II)
2. **R S Agarwal**, *A Modern Approach to Verbal and Non-Verbal Reasoning*, 3rd ed., New Delhi: S. Chand Publications, 2019. (Chapters Section I: 1,3,4,5,6,8,16, Section II: 2,3 - for Unit III & IV)

**Reference Book(s):**

1. **Dinesh Khattar**, *Quantitative Aptitude for Competitive Examinations*, 1<sup>st</sup> ed., New Delhi: Pearson India, 2019.
2. **Nishit K Sinha**, *Reasoning for Competitive Examinations*, 1<sup>st</sup> ed., New Delhi: Pearson India, 2019.
3. **R. N. Thakur**, *General Intelligence and Reasoning*, 1<sup>st</sup> ed., New Delhi: McGraw Hill Education, 2017.

| Course Articulation Matrix (CAM): |            |      |      |      | U24VA306A QUANTITATIVE APTITUDE & LOGICAL REASONING |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|-----------------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                                                | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24VA306.1 | 1    | 2    | -    | 1                                                   | -    | -    | -    | -    | -    | -     | 1     | 1     | -     |
| CO2                               | U24VA306.2 | 1    | 2    | -    | 1                                                   | -    | -    | -    | -    | -    | -     | 1     | 1     | -     |
| CO3                               | U24VA306.3 | -    | 1    | -    | 2                                                   | -    | 2    | -    | -    | -    | -     | 1     | 1     | -     |
| CO4                               | U24VA306.4 | -    | 1    | -    | 2                                                   | -    | 2    | -    | -    | -    | -     | 1     | 1     | -     |
| U24VA306                          |            | 1    | 1.5  | -    | 1.5                                                 | -    | 2    | -    | -    | -    | -     | 1     | 1     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |      |                                                     |      |      |      |      |      |       |       |       |       |

## PRACTICUM - 3

|                                        |                                       |                 |             |
|----------------------------------------|---------------------------------------|-----------------|-------------|
| <b>Class:</b> B.Tech. III semester     | <b>Branch:</b> Common to all branches |                 |             |
| <b>Course Code:</b>                    | <b>U24EL308</b>                       | <b>Credits:</b> | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>0-0-0-4-4</b>                      | <b>CIE:</b>     | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>-</b>                              | <b>ESE:</b>     | <b>-</b>    |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

**LO1:** literature review and identifying research gaps

**LO2:** implementing a project independently by applying knowledge to practice

**LO3:** preparing well-documented report and informative PPT

**LO4:** effective technical presentation and creating video pitch

Practicum is an independent project carried out by the student during the course period, under the supervision of allotted course faculty. It helps to reinforce the students' theoretical knowledge and develop their ability to apply this knowledge to the solution of practical problems. Practicums also prepare them for their MINI and MAJOR PROJECTs and for independent work in their chosen field that promotes creative abilities. Besides they provide Higher Order Cognitive Abilities (HOCAs).

- (i). Practicum is a mandatory semester project work.
- (ii). Practicum is offered as a one credit course. Student has to earn 4 credits (one in each semester from I to IV semesters)
- (iii). Allotment of Practicum topics for students:
  - a. **Practicum matrix:** In week (-1), the class teacher, in consultation with HoD, shall prepare the practicum matrix of the section. The practicum matrix is the allotment of group of students to the different course faculty of the section, as shown below.

| Course                                 | U24MH301H | U24EC302 | U24EC303 | U24EC304 | U24EC305 | U24VA306A |
|----------------------------------------|-----------|----------|----------|----------|----------|-----------|
| Students allotted to different courses | B24XX001  | B24XX011 | B24XX021 | B24XX031 | B24XX041 | B24XX051  |
|                                        | B24XX002  | B24XX012 | B24XX022 | B24XX032 | B24XX042 | B24XX052  |
|                                        | B24XX003  | B24XX013 | B24XX023 | B24XX033 | B24XX043 | B24XX053  |
|                                        | B24XX004  | B24XX014 | B24XX024 | B24XX034 | B24XX044 | B24XX054  |
|                                        | B24XX005  | B24XX015 | B24XX025 | B24XX035 | B24XX045 | B24XX055  |
|                                        | B24XX006  | B24XX016 | B24XX026 | B24XX036 | B24XX046 | B24XX056  |
|                                        | B24XX007  | B24XX017 | B24XX027 | B24XX037 | B24XX047 | B24XX057  |
|                                        | B24XX008  | B24XX018 | B24XX028 | B24XX038 | B24XX048 | B24XX058  |
|                                        | B24XX009  | B24XX019 | B24XX029 | B24XX039 | B24XX049 | B24XX059  |
|                                        | B24XX010  | B24XX020 | B24XX030 | B24XX040 | B24XX050 | B24XX060  |

- b. In week (-1), the class teacher of a section shall collect 10-12 topics for practicum from each of the course teachers of that section.
- c. The class teacher, in consultation with HoD shall allot the practicum topics to the students of that section in the following format.

\*\*\*\*

### CIRCULAR

*Allotment of Practicum topics to students*

*Section : .....*

| S.No. | Roll number of the student | Practicum topic allotted | Practicum under the course | Course faculty |
|-------|----------------------------|--------------------------|----------------------------|----------------|
|       |                            |                          |                            |                |
|       |                            |                          |                            |                |
|       |                            |                          |                            |                |
|       |                            |                          |                            |                |

Note:

4. The students should meet immediately the allotted course faculty for practicum and start working on the practicum with the guidance of course faculty.
5. To complete the Practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and also outside the class work hours during weekdays.
6. The course faculty are advised to guide the allotted students for practicum during the semester course work.

(Signature of class teacher)

\*\*\*\*

- (iv). *To complete the practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and outside the class work hours during weekdays.*
- (v). There shall be only continuous Internal Evaluation (CIE) for practicum for a maximum of 100 marks.
- (vi). The practicum course faculty shall evaluate & submit the final marks of the allotted students in week (N+1) to the respective class teacher.
- (vii). The class teacher shall collect the final marks of practicum of the students allotted to each course teacher and submit them to the CoE.
- viii). Course faculty shall follow his/her own rubrics for practicum evaluation. Focus shall be on knowledge, skills & qualities acquired by the student during the practicum course
- (ix). A sample rubric for assessment and evaluation of practicum is as follows:

|                                                               |                  |
|---------------------------------------------------------------|------------------|
| Literature survey & Identification of research gaps           | 10 marks         |
| Working model / process / software package / system developed | 30 marks         |
| Report writing (subjected to max of 30% plagiarism)           | 20 marks         |
| Oral presentation with PPT and viva-voce                      | 20 marks         |
| Video pitch                                                   | 20 marks         |
| <b>Total</b>                                                  | <b>100 marks</b> |

**Note:** It is mandatory for the student to appear for oral presentation and viva-voce to qualify for course evaluation of Practicum.

- (a) **Practicum Topic:** Each student shall be allotted a topic for practicum by the course faculty member attached to him/her. Interested students can work on their own title for practicum, but with due approval from course faculty.
- (b) **Working Model:** Each student is required to develop a prototype / process / system/simulation model on the given practicum topic and demonstrate/present, during the allotted time, before the course teacher.

- (c) **Report:** Each student is required to submit a well-documented report on the allotted practicum topic as per the format specified by the course faculty. The student shall include answers to the following questions in the report and ppt presentation.
  - i. What was the objective of the practicum assigned?
  - ii. What are the main responsibilities and tasks for practicum?
  - iii. What knowledge and skills from the coursework are applied in the practicum?
  - iv. What new knowledge and skills are acquired during the practicum?
  - v. In what ways, can the practicum be helpful for the professional career?
  - vi. What gaps are identified in your practicum work?
  - vii. What improvements or changes you suggest for addressing the identified gaps for future work?
- (d) **Anti-Plagiarism Check:** The practicum report should clear plagiarism check as per the Anti-Plagiarism policy of the institute
- (e) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the course teacher as per the schedule notified by the department
- (f) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her Practicum. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include evidence like videos & pics at the time of implementing the practicum and also key points about his / her business idea / plan (*if any*) and social impact
- (g) The student has to register for the Practicum as a supplementary examination in the following cases:
  - i) he/she is absent for oral presentation and viva-voce
  - ii) he/she fails to submit the report in prescribed format
  - iii) he/she fails to fulfill the requirements of Practicum evaluation as per specified guidelines

#### **Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

- CO1:** synthesize literature survey, identify research gaps and define objective & scope of practicum problem
- CO2:** apply knowledge to design & conduct experiments, utilize modern tools for solution of practicum problem and develop working model/ process/ system
- CO3:** demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through practicum
- CO4:** create a video pitch on practicum and make an effective oral presentation using PPTs

| Course Articulation Matrix (CAM): |            |      |      |      | U24EL308 PRACTICUM-3 |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|----------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EL308.1 | 2    | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| CO2                               | U24EL308.2 | 2    | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| CO3                               | U24EL308.3 | 2    | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| CO4                               | U24EL308.4 | 2    | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| U24EL308                          |            | 2    | 2    | 2    | 2                    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     | 2     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |      |                      |      |      |      |      |      |       |       |       |       |

## SOCIAL EMPOWERMENT ACTIVITY / SELF ACCOMPLISHMENT ACTIVITY (SEA/SAA) – 3

|                                        |                                       |                 |             |
|----------------------------------------|---------------------------------------|-----------------|-------------|
| <b>Class:</b> B.Tech. III semester     | <b>Branch:</b> Common to all branches |                 |             |
| <b>Course Code:</b>                    | <b>U24VA309XXXXX</b>                  | <b>Credits:</b> | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>0-0-0-2-2</b>                      | <b>CIE:</b>     | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>-</b>                              | <b>ESE:</b>     | <b>-</b>    |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

- LO1: holistic development** through activity-based learning to gain real-life experience which effectively help individuals deal appropriately with problems/challenges
- LO2: positive mindset** by actively adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity and handling rejection in life
- LO3: skills for effective fieldwork practice**, which include ethics, observation, communication, interviewing, problem solving, time management, organisation and documentation
- LO4: making a well-documented report and an effective oral presentation** through PPTs portraying knowledge, skills, qualities acquired and social impact of the activity

Activity Based Liberal Learning about Life, Literature and Culture (ABLL@LLC) is introduced for building **generic competencies** in students. ABLL is aimed at all dimensional holistic growth of the learner. The holistic development includes the **physical, emotional, cognitive, spiritual and social aspects**. This is an area which opens the decision-making process, helps the student to develop creativity, an analytical mind, and builds resilience, confidence, hope, well-being and success. This will help student face the world with a greater degree of maturity, stoic and become a wholesome person in the society.

It is more than just learning from books to lead a successful life. These activity-based liberal learning courses, which help students to expand their social roles later in life, are offered under two sequels namely **SEA** (Social Empowerment Activities) and **SAA** (Self Accomplishment Activities)

These SEA/SAA courses also focus on building positive mindset: adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity in your life will help student develop and maintain a positive mindset.

- (a) Each SEA/SAA activity is treated as one credit course
- (b) Student must select one activity per semester, through first 04 semesters, from the courses listed under SEA/ SAA, before commencement of the semester.
- (c) Students are required to earn minimum 04 credits under SEA/SAA, by completing minimum 02 credits through SEA and minimum 02 credits through SAA
- (d) To complete these activities student shall work outside the class work hours, during weekends, holidays, semester breaks, etc.,
- (e) If a student is not able to attend/ fulfil performance requirements, he/she shall be dropped from the course and shall have to enroll in the forthcoming semesters.

### Monitoring SEA/SAA:

- (f) **Nodal units:** The Student Activity Centre (SAC) and Centre for Innovation Incubation

Research and Entrepreneurship (C-i<sup>2</sup>RE) shall act as nodal units for activities listed under SEA/SAA.

- (g) During the semester period, the student has to **acquire requisite knowledge, conduct fieldwork**, acquire skills and propose unique solutions to the real-life problems

(h) **Knowledge Acquisition & Skilling:**

- i. Students have to identify goals, acquire and accumulate knowledge on the chosen SEA/SAA activity
  - ii. For the activities related to social awareness/issues/challenges that affect society, use the knowledge base, apply relevant skills to analyses the issue and propose unique possible solutions to the social issues/challenges. Practice to acquire necessary skills to seek new opportunities in their personal and professional life.
  - iii. For the activities related to physical fitness, music, dance, fine arts, etc., guided practice sessions under supervision of expert/guru are to be planned and executed to acquire the benchmark skills to be demonstrated.
- (i) **Fieldwork:** Fieldwork is an essential component of learning for gaining real-life experiences. In addition to knowledge acquisition & skilling, student has to take up fieldwork on the chosen activity, as part of SEA/SAA course.
- i. This student-driven Fieldwork allow students to interact with the 'real world'. It is an autonomous learning (self-learning) situation that students are more actively involved during the activity and develop a deeper understanding and develop a more positive attitude.
  - ii. Fieldwork consists of three phases: preparation, the actual activity and feedback
  - iii. As part of fieldwork, student has to interact with at least two eminent personalities/achievers/renowned persons/inspiring and great personalities related to the activity chosen.
  - iv. Fieldwork will benefit students for any careers where they need to work with communities of people or which involves analysis of complex processes, especially social and cultural.
  - v. Certain skills are required for effective fieldwork, which include observation, communication, interviewing, problem solving, documentation, and more
  - vi. Other skills important for fieldwork practice include the ability to act in a crisis, to plan, set priorities, mobilize resources, and implement the plan effectively. These skills used in an integrated manner help students solve their problems and to develop one's own leadership style based on the need and culture of the place.
  - vii. Eminent personalities/achievers/renowned persons/inspiring and great personalities

Eminent personalities/ Achievers / Renowned personalities:

(a). **In case of socially relevant problems/ activities of SEA/SAA:** Eminent personalities/ achievers include district administrative officers, Eminent Social workers / NGOs, other inspiring and great personalities

(b). **In case of Sports / Games and Cultural activities of SEA/SAA:** Eminent coaches/ trainers/gurus, achievers who represented/ won state level/ national level / international level competitions, other inspiring and great personalities.

- i. **For appointment to interact eminent personalities:** Student is expected to follow

- email etiquette rules and other appropriate polite communication etiquettes for getting appointment and time for interaction
- ii. On fieldwork, student is expected to demonstrate solid time management, organizational and note taking skills during fieldwork
  - iii. **Ethics of fieldwork:** Fieldwork is an educational process with commitment to positive values. All fieldwork should be planned and conducted in a way that is ethical, responsible and safe, for people, students, visited communities, if any, and all other stakeholders. Student is expected to maintain integrity and honesty. Avoid bias and deception. Protect the rights and well-being of people involved in fieldwork. The privacy, confidentiality and respect for the eminent people interacted should be maintained and their time, inputs & guidance are to be acknowledged
  - iv. Student is expected to take care of health and Safety practices for fieldwork and travel
  - v. Student should remember that contrary to a *field trip or company visit*, **the emphasis in fieldwork is on acquiring skills**, and not on casually presenting theory and assessing.
  - vi. For the fieldwork, student shall go with a scientifically designed questionnaire and record the responses during interaction. These response sheets, along with geo-tagged pic of fieldwork (at the time of interaction & practice sessions, if any) shall be appended as annexures in the report to be submitted for course evaluation.
  - vii. **Feedback:** The learnings the student made out of interaction with eminent achievers shall be presented in the report as one of the chapters.
  - viii. During feedback, the central focus is on the elaboration of the students' experience during fieldwork. Therefore, the student should create an end product, such as a demonstration/presentation and report in which they demonstrate a link between their experiences during fieldwork and the underlying theoretical concepts and ideas.
- (j) **Demonstration / Presentation and Report:** Student after presentation/demonstration of his/her achievements/work, shall get a certificate from the concerned nodal unit and submit a report, in the prescribed format, to the faculty counsellor for award of grade.
- (k) **Flow process for completion of SEA/SAA course:**
- vi. **Faculty counsellor approval:** In week (-1), in consultation with faculty counsellor, every student shall, identifies minimum of 4 activities listed under SEA/SAA activities, lists their priority and fills the same in ONLINE REGISTRATION FORM FOR SEA/SAA (received in their domain mail id) to Dean, Student Affairs. Dean, Student Affairs shall release the section wise allotment of SEA/SAA courses to students along with the details of supervising faculty of nodal center. The allotment details shall be shared to the SEA/SAA coordinator and the student through domain mail id of the student
  - vii. **Identification of goals and preparation of action plan:** In week (1), the respective faculty coordinator(s) of nodal centers shall address the students

- allotted to them to educate them on fixing goals, plan of action for completion and evaluation. In consultation with nodal center, based on the workflow of the allotted activity, every student shall identify the goals (of activity) & eminent personalities (to be visited during the field trip) and prepare action plan (oriented workflow) for attaining the identified goals.
- viii. **Field work:** Under the guidance of nodal center, student shall complete the field work, based on the action plan, with the progress continuously monitored by the faculty counsellor and the nodal center.
  - ix. **Demonstration/ Presentation:** After completion of field work, student shall demonstrate/present his achievements (knowledge/skills gained during the activity) at the nodal center in the presence of external experts/senior practitioners of the activity. After successful demonstration/presentation, the nodal center shall provide a certificate of completion indicating that the student has completed the activity in the stipulated time.
  - x. **Report writing:** After successful demonstration/presentation, student shall write a 2-3-page report and submit the same to the faculty counsellor. The report shall emphasize knowledge, skills and qualities acquired through the SEA/SAA activities. It shall also include the influence of these activities on enhancing confidence, positive change in life, decision making, transforming choices into desired actions/outcomes.
- (l) **Assessment & Evaluation:** There shall be *only Continuous Internal Evaluation (CIE)* for SEA/SAA. The SEA/SAA activities shall be evaluated at the end of the semester through respective evaluation processes, which shall include field work, presentation/ demonstration, submission of reports on the gathered data/information/ surveys, the details of which have been shown in below table. The department level SEA/SAA coordinator shall collect marks from the nodal centers and faculty counsellors, consolidate them, and submit the final grades to the examination branch, within one week of the last day of instruction. Evaluation of SEA/SAA activities shall be completed as and when students are ready, but not later than week (N+1).

The CIE for SEA/SAA is as follows:

| Assessment                                     | Maximum marks | Marks to be awarded by |
|------------------------------------------------|---------------|------------------------|
| Goal setting, Planning & Knowledge Acquisition | 20            | Nodal center           |
| Field work                                     | 40            | Nodal center           |
| Demonstration/Presentation                     | 20            | Nodal center           |
| Report submission                              | 20            | Faculty counsellor     |
| <b>Total</b>                                   | <b>100</b>    | -                      |

**Note:**

- (f) **Presentation/ Demonstration:** It is mandatory for the student to appear for demonstration and (or) oral presentation oral presentation to qualify for course

evaluation. In case of presentation, student should prepare PPT with informative slides including the geo tagged photos of his/her field trips/interactions as per the schedule notified by the nodal center. In case of demonstration, student must take timeslot from the nodal center and demonstrate the skills learnt/improved during the allotted timeslot.

- The necessary arrangements for demonstration shall be looked after the student in consultation with the coordinator with due permission from Head of the department.
- (g) **Report:** Each student is required to submit a well-documented report on the chosen SEA/SAA topic as per the format specified by *department level SEA/SAA coordinator*.
- (h) **Anti-Plagiarism Check:** The SEA/SAA report should clear plagiarism check as per the Anti-Plagiarism policy of the institute.
- (i) **Requirements for passing the course:** A student is deemed to have passed SEA/SAA if he/she
  - a. successfully demonstrates/presents the skills attained at the end of course as per the schedule notified by the nodal center, **and**
  - b. scores a minimum of 40 marks in the CIE of the course
- (j) **Supplementary examination:** If a student fails in SEA/SAA activity of a particular semester, he must complete the same by enrolling it in the next higher semesters.

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

- CO1:** integrate the five dimensions of physical, emotional, cognitive, spiritual and social aspects in life for holistic development and demonstrate social sensibility
- CO2:** interact effectively through written, oral and nonverbal communication with external-world in a professional, sensitive and culturally relevant manner
- CO3:** analyses the issues related to social empowerment / self-accomplishment, demonstrate problem-solving skills, articulate solutions and demonstrate social sensibility
- CO4:** demonstrate the generic competencies in making a well-documented report and an effective oral presentation with PPTs portraying knowledge, skills, qualities acquired through fieldwork/practice sessions and social impact of the course learning

**Text / Reference Book(s):**

*For knowledge acquisition, students shall refer to textbooks and web resources relevant to the course selected. Plan for fieldwork/practice sessions in coordination with SEA/SAA coordinator*

| Course Articulation Matrix (CAM): |                 | U24VA309XXXXX - Courses listed under SEA/ SAA |         |         |         |         |         |         |         |         |          |          |          |          |
|-----------------------------------|-----------------|-----------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO                                |                 | PO<br>1                                       | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 |
| CO1                               | U24VA309XXXXX.1 | -                                             | -       | -       | -       | -       | 2       | 2       | 2       | 2       | 2        | 2        | -        | -        |
| CO2                               | U24VA309XXXXX.2 | -                                             | -       | -       | -       | -       | 2       | 2       | 2       | 2       | 2        | 2        | -        | -        |
| CO3                               | U24VA309XXXXX.3 | -                                             | -       | -       | -       | -       | 2       | 2       | 2       | 2       | 2        | 2        | -        | -        |
| CO4                               | U24VA309XXXXX.4 | -                                             | -       | -       | -       | -       | 2       | 2       | 2       | 2       | 2        | 2        | -        | -        |
| U24VA309XXXXX                     |                 | -                                             | -       | -       | -       | -       | 2       | 2       | 2       | 2       | 2        | 2        | -        | -        |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |                 |                                               |         |         |         |         |         |         |         |         |          |          |          |          |

**Course Code: U24VA XYY(SE/SA) ZZZ**

*X represents semester; YY represents SEA/SAA course serial number in that semester; SE- represents SEA activity or SA – represents SAA activity; ZZZ represents activity code from SEA/SAA baskets*

|                                                                                                                                                                            |                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex: If A student selects a SEA/SAA course as below:                                                                                                                        | Ex: If A student selects a SEA/SAA course as below:                                                                                                                        |
| <i>Semester: 1</i><br><i>SEA/SAA course serial number: 09</i><br><i>SEA/SAA category: SEA</i><br><i>course number: 302</i><br>The <b>course code</b> will be U24VA109SE302 | <i>Semester: 4</i><br><i>SEA/SAA course serial number: 10</i><br><i>SEA/SAA category: SAA</i><br><i>course number: 206</i><br>The <b>course code</b> will be U24VA410SA206 |

## EXPERT TALK SERIES – 3

|                                        |                                       |                 |             |
|----------------------------------------|---------------------------------------|-----------------|-------------|
| <b>Class:</b> B.Tech. III- Semester    | <b>Branch:</b> Common to all branches |                 |             |
| <b>Course Code:</b>                    | <b>U24AE310</b>                       | <b>Credits:</b> | <b>1</b>    |
| <b>Hours/Week (L-T-P-O-E):</b>         | <b>0-0-0-1-1</b>                      | <b>CIE:</b>     | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>-</b>                              | <b>ESE:</b>     | <b>-</b>    |

### Course Learning Objectives (LOs):

*This course will develop students' knowledge in /on...*

- LO1:** 21<sup>st</sup> century skills needed for industry, current industry trends, challenges and innovations
- LO2:** latest technology in practice and applying knowledge to solve real-world problems
- LO3:** smart work, soft skills, professional etiquette, networking abilities
- LO4:** making a well-documented report portraying the knowledge, skills, qualities acquired and the impact of the learning

**In the 21<sup>st</sup> century, for successful career, degree alone won't suffice. Competencies are much more important.**

- (a) You need to be aware of the real-world problems, industry working style, need to be confident and smart and you also need to know the tricks of the trade.
- (b) Learning from industry experts with real-world examples, is important to enhance your educational experience.
- (c) Enhanced graduate employability benefits all stakeholders. To effectively enhance employability and the immediacy of adding value to company/project, it is important that you are aware of what you are learning and its use in the workplace. The cognitive abilities viz., remember, understand, recall, and application of knowledge and other skills acquired in higher education can be maximized if you are clear on the purpose of your developed competencies and how to apply them in a range of complex situations.
- (d) Graduate employability could be enhanced through fostering lifelong learning, the development of a range of employability-related competencies and increased confidence and capacity in "reflecting on and articulating these capabilities and attributes in a range of recruitment situations".

**But how would you know all this without venturing into the industry?**

- (e) The answer is Industry **Expert Talk Series (ETS)**. Through ETS, we invite industry experts in different fields to deliver talks and interact with students.
- (f) Through Industry expert talks students get to know so much more that textbooks don't explain.
- (g) Students have the opportunity to learn from professionals who have achieved success in their respective fields. These speakers often share their personal experiences, case studies, and anecdotes, providing students with real-world examples and perspectives that go beyond theoretical concepts.
- (h) Our competency-focused curriculum URR24 is designed to contribute greatly to the nurturing and development of each of these facets among students through ETS courses
- (i) ETS helps students gain improved industry engagement for an easier transition into the workplace, broader career progression opportunities and personal development.
- (j) In URR24 curriculum, Expert talk series (ETS) is offered as a course under **ability enhancement category of courses**.
- (k) Through ETS sessions, students get the chance to interact with industry regularly which

helps them focus on the needs and requirements of current industry. This will not only enthuse the students with new ideas but also motivate them to understand what kind of 21<sup>st</sup> century skills are needed in industry and how they need to groom themselves.

- (l) Through ETS sessions, another benefit is that students learn the importance of soft skills like communication, presentation, email etiquettes, corporate grooming and dressing styles. Conversing with successful people is the biggest motivation and students gain in more ways than one through ETS sessions.
- (m) ETS enhances your learning in many ways for global opportunities for your career.
- (n) All in all, learning from industry experts, is a wonderful opportunity for student to getting acquainted with professional etiquette, acquiring professional knowledge, and getting to know the internal workings of an organization.
- (o) Salient features of ETS are hereunder:
  - (i) ETS is offered from I semester to VI semester.
  - (ii) ETS, in any given semester, is treated as one credit course
  - (iii) Students are required to earn six credits (from I to VI semester)
  - (iv) **Head, Centre for i<sup>2</sup>RE** shall be the **institute level ETS coordinator**
  - (v) Under this course, a minimum of 10 expert talks shall be organized in **online/offline mode** by the parent department / Centre for i<sup>2</sup>RE.
  - (vi) Each expert talk shall be for a minimum duration of 45 minutes (*but not exceeding 90 minutes*) followed by **online quiz/test** for 10 marks (10 MCQs/FiBs; *duration: 10-15 mins*), on the contents covered in the expert talk.
  - (vii) **The Head C-i<sup>2</sup>RE** shall share the marks obtained by the students in each of the quizzes / tests to the respective **department ETS coordinators**.
  - (viii) Each student shall attend a minimum of 6 expert talks and attempt the corresponding quizzes/ tests conducted at the end of the talks.
  - (ix) **Report on ETS:** At the end of semester, the student shall submit a well-documented report on the acquired knowledge and skills, in the prescribed format, to the department ETS coordinator.
  - (x) **Evaluation:** There shall be only continuous Internal Evaluation (CIE) for ETS for a maximum of 100 marks
  - (xi) The department ETS coordinator shall, in coordination with institute level ETS coordinator, submit the final scores to the CoE in week (N+1).

(p) The CIE for ETS is as follows:

*Rubrics for evaluation of ETS*

|                                                                                               |                  |
|-----------------------------------------------------------------------------------------------|------------------|
| Quiz score<br>(Sum of best 6 quiz scores out of 10 quizzes. Each quiz evaluated for 10 marks) | 60 marks         |
| Attendance (out of 10 quizzes)                                                                | 20 marks         |
| Report in prescribed format (max 30% plagiarism)                                              | 20 marks         |
| <b>Total</b>                                                                                  | <b>100 marks</b> |

- ii. **Attendance:** Maximum of 20 marks shall be awarded based on the attendance maintained by the student over a maximum of 10 lectures.

$$\text{Marks for attendance} = \frac{\text{Number of expert talks attended fully}}{10} * 20$$

iii. **Supplementary Exam:**

- (a) Student has to register for ETS supplementary examination if he/she scores less

than 40 marks in CIE

- (b) The ETS supplementary examination shall be conducted by the parent department, in physical mode, for 100 marks (MCQs/FiBs; *duration: 2Hrs*) on the content covered in ETS lectures.
- (c) Department ETS coordinator shall, in coordination with the institute level ETS coordinator, conduct the supplementary exam, and submit scores to the CoE
- (d) Exam material/resources for supplementary: Recorded videos of ETS arranged for that semester, which shall be made available on ETS webpage of institute website

### Course Learning Outcomes (COs):

*After completion of this course, the students should be able to...*

**CO1:** identify real-world problems, different career paths, industry requirements, emerging job roles, business practices and exploit new opportunities by staying up-to-date with industry knowledge, trends and technology

**CO2:** identify what 21<sup>st</sup> century employability-related skills and professional etiquette are must in a range of recruitment situations, what skills are absent in him/her, and demonstrate skill improvement

**CO3:** interact with experts, exhibit confidence, demonstrate improved communication and networking abilities potentially leading to mentorship opportunities, internships, or even future job prospects

**CO4:** demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through ETS sessions and impact of the expert talks

| Course Articulation Matrix (CAM): |            |      |      | U24AE310    EXPERT TALK SERIES - 3 |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                               | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24AE310.1 | 1    | 1    | 1                                  | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| CO2                               | U24AE310.2 | 1    | 1    | 1                                  | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| CO3                               | U24AE310.3 | 1    | 1    | 1                                  | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| CO4                               | U24AE310.4 | 1    | 1    | 1                                  | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| U24AE310                          |            | 1    | 1    | 1                                  | 1    | 1    | 1    | 2    | 1    | 2    | 1     | 2     | 1     | 1     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |            |      |      |                                    |      |      |      |      |      |      |       |       |       |       |

Course code U24AE3YY: *X represents semester, YY represents ETA course serial number*

# 4<sup>th</sup> Semester Syllabus

#### IV SEMESTER

| S. No.                                                                                                                                                   | Category | Course Code | Course Title                                 | Lectures / week |   |    |    | Credits |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|----------------------------------------------|-----------------|---|----|----|---------|
|                                                                                                                                                          |          |             |                                              | L               | T | P  | E  | C       |
| 1                                                                                                                                                        | PCC      | U24EC401    | Integrated Circuits Applications             | 2               | 1 | -  | 3  | 3       |
| 2                                                                                                                                                        | PCC      | U24EC402    | Communication Systems                        | 2               | 1 | -  | 3  | 3       |
| 3                                                                                                                                                        | PCC      | U24EC403    | Electromagnetic Waves and Transmission Lines | 2               | 1 | -  | 3  | 3       |
| 4                                                                                                                                                        | PCC      | U24EC404    | Computer Organization and Microprocessors    | 2               | 1 | -  | 3  | 3       |
| 5                                                                                                                                                        | ESC      | U24EC405    | Python Programming                           | 2               | 1 | -  | 3  | 3       |
| 6                                                                                                                                                        | VAC      | U24VA406B   | Soft and Interpersonal Skills®               | -               | - | 2  | 2  | 1       |
| 7                                                                                                                                                        | SEC      | U24SE407    | Programming Skill Development Lab - 3        | -               | - | 2  | 2  | 1       |
| 8                                                                                                                                                        | PCC      | U24EC408    | Integrated Circuits Applications Laboratory  | -               | - | 2  | 2  | 1       |
| 9                                                                                                                                                        | PCC      | U24EC409    | Communication Systems Laboratory             | -               | - | 2  | 2  | 1       |
| 10                                                                                                                                                       | ESC      | U24EC410    | Python Programming Laboratory                | --              | - | 2  | 2  | 1       |
| 11                                                                                                                                                       | VAC*     | U24CY411*   | Environmental Sciences*                      | 2*              | - | -  | 5* | -       |
| Total:                                                                                                                                                   |          |             |                                              | 10              | 5 | 10 | 25 | 20      |
| Summer/ Inter-Sem Mandatory Bridge Courses: 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet) |          |             |                                              | -               | - | -  | -  | -       |

*\*For Lateral Entry Students Only*

| INTEGRATED CIRCUITS APPLICATIONS                                                                                                                                                                                                                                                                                        |            |             |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-------|
| Class: B.Tech. IV -Semester                                                                                                                                                                                                                                                                                             |            | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                            | U24EC401   | Credits:    | 4     |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                 | 2-1-2-5-10 | CIE :       | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                         | 60 Hrs     | ESE :       | 40%   |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                       |            |             |       |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                  |            |             |       |
| LO1: building blocks & characteristics of Op-Amp                                                                                                                                                                                                                                                                        |            |             |       |
| LO2: linear and non-linear applications of Op-Amps                                                                                                                                                                                                                                                                      |            |             |       |
| LO3: active filters using Op-Amps and operation of IC 555 timer & its applications                                                                                                                                                                                                                                      |            |             |       |
| LO4: operation of PLL, voltage regulators and data converters                                                                                                                                                                                                                                                           |            |             |       |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                        |            |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                  |            |             | 9 Hrs |
| Integrated Circuits (ICs): Introduction, Classification of ICs                                                                                                                                                                                                                                                          |            |             |       |
| Operational Amplifier (Op-Amp): Differential Amplifiers, Dual input balanced output differential amplifier, Dual input unbalanced output differential amplifier; Building blocks of Operational Amplifier (Op-Amp); Analysis of Basic Inverting & Non-Inverting Amplifier configurations and voltage follower           |            |             |       |
| DC Characteristics of Op-Amp: Input offset voltage, Input bias current, Input offset current, Total output offset voltage, Thermal drift, Supply Voltage Rejection Ratio (SVRR), Common Mode Rejection Ratio (CMRR)                                                                                                     |            |             |       |
| AC Characteristics of Op-Amp: Open loop and closed loop frequency response, stability of Op- Amp, slewrate, Ideal&PracticalcharacteristicsofIC $\mu$ A741                                                                                                                                                               |            |             |       |
| Self Learning Topics (SLTs): Integrated Circuits (ICs): Introduction, Classification of IC's (Text1: chapter 1)                                                                                                                                                                                                         |            |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                 |            |             | 9 Hrs |
| Linear Applications of Operational Amplifiers: Summing and difference amplifiers,Integrator and Differentiator, Current-to-Voltage and Voltage-to-Current converters, Instrumentation amplifier, Sample and Hold circuit                                                                                                |            |             |       |
| Non-Linear Applications: Precision Rectifiers – Half wave and Full wave, Logarithmic amplifier                                                                                                                                                                                                                          |            |             |       |
| Comparators and Wave form generators: Op-Amp comparators, Regenerative Comparator (Schmitt Trigger), and Wien's bridge oscillator                                                                                                                                                                                       |            |             |       |
| Self Learning Topics (SLTs): Anti-log amplifier (Text1: topic 4.8), Solved problems (Text1: Problems 4.14)                                                                                                                                                                                                              |            |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                |            |             | 9 Hrs |
| Active Filters:First order, Second order filters-Analysis and design of V.C.V.S configured Lowpass, high pass, Band pass and Band Stop filters, I.G.M.F. configured narrow band pass and narrow band reject filter, Twin T-notch filter                                                                                 |            |             |       |
| Monolithic Timers and their applications: Functional Diagram of timer, Design of Astable and Monostable multivibrators using 555 timer, Applications of Astable Multivibrator – FSK Generator, Pulse-Position Modulation, Schmitt Trigger, Applications of Monostable Multivibrator- Linear Ramp Generator, Pulse-Width |            |             |       |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Modulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
| <i>Self Learning Topics (SLTs): Second order low &amp; high pass filters (Text1: topic 7.2), Applications of IC 555 Timer: Missing pulse detector, Pulse-width modulation (Text1: topics 8.3, 8.4), Solved problems (Text1: Prob 8.5)</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>9 Hrs</b> |
| <b>Voltage Regulators:</b> Basic voltage regulator using Op-Amps, General purpose IC regulator, $\mu$ A723 - Functional diagram, Specifications, Three terminal voltage (fixed) regulators- General features and IC series of three terminal regulators<br><b>Data Converters:</b> DAC types - R-2R ladder; ADC types - Flash, Successive approximation & Dual slope<br><b>Phase Locked Loops (PLLs) (Qualitative treatment only):</b> Voltage controlled oscillator, Basic PLL operation, Definitions related to PLL, PLL application - FSK and AM detectors<br><i>Self-Learning Topics (SLTs): Design of low &amp; high voltage regulators (Text1: topics 6.2, 6.3), Weighted resistor (Text1: topics 10.2)</i>                                                                                                                                                                                                         |              |
| <b>LABORATORY COMPONENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |              |
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
| <ol style="list-style-type: none"> <li>1. Design an inverting and non inverting amplifier using Op-Amp IC 741</li> <li>2. Design and testing of Adder and Subtractor circuits using IC 741</li> <li>3. Design and testing of differentiator using IC 741</li> <li>4. Design and testing of integrator using IC 741</li> <li>5. Design and testing of Instrumentation Amplifier using 3-Op-Amps IC 741</li> <li>6. Design and testing of log amplifier using Op-Amp IC 741</li> <li>7. Design and testing precision rectifier using Op-Amp IC 741</li> <li>8. Design and testing of Wien's bridge oscillator using IC 741</li> <li>9. Design and testing of astable multivibrator using IC 555</li> <li>10. Design and testing of monostable multivibrator using IC 555</li> <li>11. Design and testing of second order active low pass filter using IC 741</li> <li>12. Design a voltage regulator using IC723</li> </ol> |              |
| <b><u>TextBook(s):</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
| <ol style="list-style-type: none"> <li>1. D.Roy Choudhury and Shail B Jain, "Linear Integrated Circuits", 4th ed. New Age International, 2010</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |
| <b><u>Reference Book(s):</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |
| <ol style="list-style-type: none"> <li>1. Ramakant Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th ed. Pearson Education, New Delhi, 2015</li> <li>2. George B. Clayton, "Linear Integrated Circuits and Applications", The Macmillan Press Ltd., London, 1975</li> <li>3. Rodert F.Coughlin and Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", 6th ed. Pearson Education, New Delhi, 2000</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |

4. S. Salivahanan and V S Kanchana Bhaaskaran, "Linear Integrated Circuits", 3rd ed. Chennai: McGraw Hill Education (India) Pvt. Ltd., 2019

**Web and Video link(s):**

1. [https://onlinecourses.nptel.ac.in/noc24\\_ee73/preview](https://onlinecourses.nptel.ac.in/noc24_ee73/preview) NPTEL Video Lecture on Integrated Circuits and Applications by Prof. Shaik rafi Ahamed, IIT Guwahati

**Laboratory Manual (for laboratory component):**

1. Integrated Circuits Applications Laboratory Manual and Record Book, Department of ECE, KITSW

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

CO1: analyze characteristics of Op-Amp IC741 using fundamental concepts

CO2: design Op-amp based simple linear & non-linear circuits for the given specifications

CO3: analyze Op-amp based active filters and IC 555 timer-based multivibrator circuits

CO4: design IC PLL based application circuits, IC 723 based voltage regulators for the given specifications and choose suitable data converter for given design specifications

*(based on psychomotor skills acquired from laboratory component)*

CO5: design and test the functionality of Op-amp circuits for linear applications such as differentiators and integrators

CO6: design and test the functionality of Op-amp circuits non-linear applications such as log amplifier and precision rectifier

CO7: examine the active filters using IC741

CO8: build and test the multivibrators using IC 555

| Course Articulation Matrix (CAM): |            |      |      | U24EC401 INTEGRATED CIRCUITS APPLICATIONS |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|-------------------------------------------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3                                      | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC401.1 | 2    | 2    | 1                                         | 1    | 1    | 1    | 1    | 1    | 1    | -     | 1     | 2     | 3     |
| CO2                               | U24EC401.2 | 2    | 2    | 1                                         | 1    | 1    | 1    | 1    | 1    | 1    | -     | 1     | 3     | 3     |
| CO3                               | U24EC401.3 | 2    | 2    | 1                                         | 1    | 1    | 1    | 1    | 1    | 1    | -     | 1     | 2     | 3     |
| CO4                               | U24EC401.4 | 2    | 2    | 1                                         | 1    | 2    | 2    | 1    | 1    | 1    | -     | 1     | 3     | 3     |
| CO5                               | U24EC401.5 | 2    | 2    | 1                                         | 1    | 3    | 1    | 1    | 2    | 2    | 1     | 1     | 2     | 2     |
| CO6                               | U24EC401.6 | 2    | 2    | 1                                         | 1    | 2    | 2    | 1    | 2    | 2    | 1     | 1     | 3     | 2     |
| CO7                               | U24EC401.7 | 2    | 2    | 1                                         | 1    | 1    | 2    | 1    | 2    | 2    | 1     | 1     | 2     | 2     |
| CO8                               | U24EC401.8 | 2    | 2    | 1                                         | 1    | 1    | 2    | 1    | 2    | 2    | 1     | 1     | 3     | 2     |
| U24EC401                          |            | 2    | 2    | 1                                         | 1    | 1.5  | 1.5  | 1    | 1.5  | 1.5  | 1     | 1     | 2.50  | 2.5   |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                                           |      |      |      |      |      |      |       |       |       |       |

| COMMUNICATION SYSTEMS                                                                                                                                                                                                                                                                                                                                                     |            |                |    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------|----|
| Class: B.Tech. IV -Semester                                                                                                                                                                                                                                                                                                                                               |            | Branch: ECE    |    |
| Course Code:                                                                                                                                                                                                                                                                                                                                                              | U24EC402   | Credits:       | 4  |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                   | 2-1-2-5-10 | CIE Marks (%): | 60 |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                           | 60 Hrs     | ESE Marks (%): | 40 |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                                                         |            |                |    |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                                                    |            |                |    |
| LO1: different amplitude modulation techniques                                                                                                                                                                                                                                                                                                                            |            |                |    |
| LO2: angle modulation & analog pulse modulation                                                                                                                                                                                                                                                                                                                           |            |                |    |
| LO3: source coding & digital pulse modulation techniques                                                                                                                                                                                                                                                                                                                  |            |                |    |
| LO4: bandpass data transmission systems                                                                                                                                                                                                                                                                                                                                   |            |                |    |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                                                          |            |                |    |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                    |            | 9 Hrs          |    |
| Amplitude Modulation: Introduction, Elements of communication system, Amplitude modulation, Double sideband-suppressed carrier modulation, Single sideband modulation, Vestigial sideband modulation, Noise in communication systems, Sources of noise-shot noise, White noise, Super heterodyne receiver, Intermediate frequency, AGC                                    |            |                |    |
| Self-Learning Topics (SLTs): Review on Fourier Representation of Signals and Systems (Text1: topics 2.5), Costas receiver (Text1: 3.4)                                                                                                                                                                                                                                    |            |                |    |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                   |            | 9 Hrs          |    |
| Angle Modulation: Frequency modulation, Phase modulation, Relationship between PM and FM waves, Narrow-band frequency modulation, Wide-band frequency modulation, Transmission bandwidth of FM waves, Generation of FM waves, Demodulation of FM signals-phase discriminator, Noise in FM                                                                                 |            |                |    |
| Pulse Modulation: Pulse amplitude modulation, Pulse width modulation, Pulse position modulation                                                                                                                                                                                                                                                                           |            |                |    |
| Self-Learning Topics (SLTs): Pre-emphasis and de-emphasis.(Text1: 9.8), Practice problems (Text1: Problems 3.17 to 3.28)                                                                                                                                                                                                                                                  |            |                |    |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                  |            | 9 Hrs          |    |
| Digital Modulation: Elements of digital communication system, Source coding, Measure of information, Entropy, Information rate, Source coding- Shannon Fano, Huffman coding, Gaussian channel capacity, Shannon bound, Pulse code modulation (PCM), Quantization, quantization error, Signal to quantization noise ratio, Delta modulation (DM), Comparison of PCM and DM |            |                |    |
| Self-Learning Topics (SLTs): Line Codes(Text1: topics 5.9),Solved problems (Text1: Problems 5.13, 5.14, 5.15), Differential pulse code modulation (Text1: topics 5.8)                                                                                                                                                                                                     |            |                |    |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                   |            | 9 Hrs          |    |
| Band-pass Data Transmission: Band pass data transmission system, Optimum receiver for binary digital modulation schemes, Coherent binary phase shift keying (BPSK), Differential phase shift keying (DPSK), Coherent binary frequency shift keying (BFSK), Quadrature phase shift keying (QPSK), Power and bandwidth requirements of above schemes                        |            |                |    |
| Self-Learning Topics (SLTs): Solved problems (Text1: Prob 6.4, Prob 6.5, Prob 6.7), Probability of                                                                                                                                                                                                                                                                        |            |                |    |

error of keying techniques (Text1: 10.4)

## LABORATORY COMPONENT

### List of Experiments

1. Generation of AM Signal, find the modulation index and percentage of modulation with different modulation signals
2. Study of Modulation and demodulation of DSB-SC signal
3. Calculate the modulation index, frequency deviation of FM signal
4. Study the characteristics of PLL
5. Generation and demodulation of Pulse Amplitude Modulation
6. Generation and demodulation of Pulse Width modulation & Pulse Position Modulation
7. Interpretation of modulated and demodulated waveforms of a PCM system for different sampling frequencies
8. Study of Delta Modulation & Demodulation and observe the effect of slope overload
9. Study of Amplitude Shift Keying
10. Study of Phase Shift Keying
11. Study of Frequency Shift Keying
12. Modulation and demodulation of Differential Phase Shift Keying (DPSK) signal
13. Study of QPSK modulation and demodulation for different data rates

### TextBook(s):

1. Simon Haykin and Michael Moher, *Introduction to Analog and Digital Communications*, 2nd ed. USA: John Wiley & sons, Inc., 2007 (Chapters: 3,4,5,7,9)

### Reference Book(s):

1. Herbart Taub, Donald L Schilling, *Principles of Communication Systems*, 4th ed. Tata McGraw-Hill Education, 2017.
2. Sanjay Sharma, *Analog and Digital Communication Systems*, 2nd ed. McGraw-Hill Education, 2008.
3. Bhattacharya, *Digital Communication*, Tata McGraw-Hill Education, 2017
4. K. Sam Shanmugam, *Digital and Analog Communication Systems*, New Delhi: John Wiley & Sons, 2008.

### Web and Video link(s):

1. [https://www.youtube.com/watch?v=3zVNVwr9i\\_0&list=PLq-Gm0yRYwTgX2FkPVcY6io003-tZd8Ru&index=12](https://www.youtube.com/watch?v=3zVNVwr9i_0&list=PLq-Gm0yRYwTgX2FkPVcY6io003-tZd8Ru&index=12) Spectrum of AM Signals.
2. <https://www.youtube.com/watch?v=GhBEdM-tR3A&list=PLq-Gm0yRYwTgX2FkPVcY6io003-tZd8Ru&index=30> FM with Sinusoidal Modulation Signal | IIT Kanpur.
3. <https://www.youtube.com/watch?v=4Mx13ifG5Is&list=PLq-Gm0yRYwTjdesS06WhESHJCVcJz6ibO&index=8> Digital Communication Receiver - I | IIT Kanpur.

### Laboratory Manual (for laboratory component):

1. *Analog and Digital Communications Laboratory Manual*, Department of ECIE, KITSW.

### Course Learning Outcomes (COs):

After completion of this course, the students should be able to...

- CO1:** estimate the performance of AM systems, its generation and reception
- CO2:** evaluate the performance of FM system in the presence of noise and discuss pulse modulation techniques
- CO3:** determine code efficiency of source coding algorithms and different digital modulation techniques
- CO4:** examine the performance of coherent band pass data transmission systems.

*(based on psychomotor skills acquired from laboratory component)*

- CO5 :** determine the modulation index and percentage modulation of an AM carrier from the time domain curve plot
- CO6 :** determine the modulation index and also measure the frequency deviation of an FM signal
- CO7 :** verify sampling theorem & observe the quantization process of the input analog signal in PCM, DM and analyse the effect of sampling rate on Quantization noise & step-size
- CO8 :** analyse the amplitude, frequency and phase in different shift keying techniques

| Course Articulation Matrix (CAM): |            |      |      |      | U24EC402COMMUNICATION SYSTEMS |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|-------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                          | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC402.1 | 2    | 2    | 1    | 1                             | -    | -    | 1    | 1    | 1    | -     | 1     | 1     | 2     |
| CO2                               | U24EC402.2 | 2    | 2    | 1    | 1                             | -    | -    | 1    | 1    | 1    | -     | 1     | 1     | 2     |
| CO3                               | U24EC402.3 | 2    | 2    | 1    | 1                             | -    | -    | 1    | 1    | 1    | -     | 1     | 1     | 2     |
| CO4                               | U24EC402.4 | 2    | 2    | 1    | 1                             | -    | -    | 1    | 1    | 1    | -     | 1     | 1     | 2     |
| CO5                               | U24EC402.5 | 2    | 1    | 1    | 1                             | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 2     |
| CO6                               | U24EC402.6 | 2    | 1    | 1    | 1                             | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 2     |
| CO7                               | U24EC402.7 | 2    | 1    | 1    | 1                             | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 2     |
| CO8                               | U24EC402.8 | 2    | 1    | 1    | 1                             | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 2     |
| U24EC402                          |            | 2    | 1.5  | 1    | 1                             | -    | -    | 1    | 1    | 1    | 1     | 1     | 1     | 2     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |      |                               |      |      |      |      |      |       |       |       |       |

| <b>ELECTROMAGNETIC WAVES AND TRANSMISSION LINES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                    |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B.Tech. IV -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>U24EC403</b>  | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-O-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>2-1-0-4-7</b> | <b>CIE :</b>       | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>36 Hrs</b>    | <b>ESE :</b>       | <b>40%</b>   |
| <b>Course Learning Objectives (LOs):</b><br><i>This course will develop students' knowledge in /on...</i><br><b>LO1:</b> electric field due to various charge distributions, energy stored in electrostatic field<br><b>LO2:</b> magnetic field due to various current distributions, and wave propagation in different medium<br><b>LO3:</b> poynting theorem, field components in rectangular & parallel plane waveguides<br><b>LO4:</b> transmission line equations, distortion-less transmission line, smith chart and stub-matching                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |                    | <b>9 Hrs</b> |
| Review of vector calculus, co-ordinate systems - cartesian, cylindrical and spherical, statements of Stoke's theorem and Divergence theorem<br><b>Electrostatics:</b> Coulomb's law, electric field intensity, electric field due to point charge, line charge and sheet charge, electric flux density, Gauss's law, relation between E & V, work, potential, energy stored, energy density and boundary conditions<br><i>Self Learning Topics (SLTs):</i> Poisson's and Laplace's equations(Text1: topic 5.2), Resistance and Capacitance (Text1: topic 5.5), <i>Solved problems</i> (Text1: Examples 3.1, 3.4, 3.8, 3.10,3.14 and 4.5)                                                                                                                                                                                                                                                                                                                                    |                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                    | <b>9 Hrs</b> |
| <b>Magnetostatics:</b> Biot-Savart's law, magnetic field intensity, magnetic flux density, Ampere's circuit law, magnetic field due to straight conductor and circular ring, magnetic scalar and vector potentials and boundary conditions<br><b>Time-Varying Fields:</b> Continuity equation, Faraday's law of electromagnetic induction, inconsistency of Ampere's circuit law, Maxwell's equations in differential & integral forms<br><b>Electromagnetic waves:</b> Plane wave equation and its general solution, wave propagation in lossy dielectric, loss-less dielectric, free space and good conductor, skin effect and polarization – linear, circular(left and right) and elliptical(left and right) polarizations<br><i>Self Learning Topics (SLTs):</i> Magnetic energy(Text1: topic 7.8) and Reflection of a plane wave at normal incidence(Text1: topic 9.7), <i>Solved problems</i> (Text1: Examples 6.3, 6.7,8.4,9.2 and sample GATE problems on em waves) |                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  |                    | <b>9 Hrs</b> |
| <b>Power and Poynting Vector:</b> Poynting vector, Poynting theorem, average Poynting vector and average power crossing a given surface<br><b>Waveguides:</b> Rectangular waveguides – Field components, impossibility of propagation of TEM mode, TM mode propagation and propagation characteristics and introduction to circular wave guides<br><i>Self Learning Topics (SLTs):</i> TE mode propagation in rectangular wave guide (Text1: topic 11.4), <i>Solved problems</i> (Text1: Examples 9.6, 11.3 and sample GATE problems on Average Poynting vector, Average Power and Waveguides)                                                                                                                                                                                                                                                                                                                                                                              |                  |                    |              |

| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 9 Hrs |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <p><b>Transmission Lines:</b> Primary &amp; Secondary constants, Transmission Line Equations, Infinite length transmission line, Phase velocity &amp; Group velocity, Loss-less transmission line, Condition for distortion-less transmission line, Input impedance of a transmission line, Short-circuit &amp; Open-circuit transmission lines, Quarter wave transformer, Smith chart – Construction, Properties and Applications, Single-stub matching</p> <p><b>Self Learning Topics (SLTs):</b> Transmission line equations(Text2: topic 1.7) and Stub matching(Text2: topics 6.11, 6.12, 6.13 and 6.14), <b>Solved problems</b> (Text2: Examples 1.2, 2.1, and sample GATE problems on Transmission Lines)</p> |       |
| <p><b>Course Learning Outcomes (COs):</b><br/>After completion of this course, the students should be able to...</p> <p><b>CO1:</b> determine the electric field at any given point due to various charge distributions and measure the energy stored in a given electrostatic field</p> <p><b>CO2:</b> apply biot-savart's law for determining magnetic field intensity and analyze the wave propagation in different medium</p> <p><b>CO3:</b> prove poynting theorem and derive the field components in rectangular waveguide</p> <p><b>CO4:</b> find voltage and current in a given transmission line and evaluate the impedance using smith chart</p>                                                          |       |
| <p><b><u>TextBook(s):</u></b></p> <ol style="list-style-type: none"> <li>1. Mathew N.O. Sadiku, "Principles of Electromagnetics", 4th ed. Oxford University Press, New York, 2014</li> <li>2. Umesh Sinha "Transmission Lines and Networks", 2nd ed. Satya Prakashan Publication, New Delhi, 1999</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                        |       |
| <p><b><u>Reference Book(s):</u></b></p> <ol style="list-style-type: none"> <li>1. Edward C. Jordan, Keith G. Balmain,"Electromagnetic Waves and Radiating Systems", 2nded. Pearson Education, London, 2015</li> <li>2. William H. Hayt, John A. Buck, Jaleel M. Akhtar, "Engineering Electromagnetics", 9thed.The McGraw-Hill Companies, New York, 2020</li> </ol>                                                                                                                                                                                                                                                                                                                                                  |       |
| <p><b><u>Web and Video link(s):</u></b></p> <ol style="list-style-type: none"> <li>1. <a href="https://www.youtube.com/watch?v=0OwmYAljz4A&amp;list=PL0925FD10648D664E">https://www.youtube.com/watch?v=0OwmYAljz4A&amp;list=PL0925FD10648D664E</a>;NPTEL Video Lecture on Electromagnetic Waves by Prof. R.K.Shevgaonkar, Dept of Electrical Engineering, IIT Bombay.</li> <li>2. <a href="https://www.youtube.com/watch?v=G5P6dInMTFg&amp;list=PLuv3GM6-gsE3-hVNaw-YEb7EeY5XVPZdz">https://www.youtube.com/watch?v=G5P6dInMTFg&amp;list=PLuv3GM6-gsE3-hVNaw-YEb7EeY5XVPZdz</a>; NPTEL Video Lecture on Electromagnetic Theory by Prof. K. Pradeep Kumar, Dept of Electrical Engineering, IIT Kanpur.</li> </ol>   |       |

| Course Articulation Matrix (CAM): |            |      |      |      | U24EC403 ELECTROMAGNETIC WAVES AND TRANSMISSION LINES |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|-------------------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                                                  | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC403.1 | 2    | 2    | 2    | 2                                                     | 2    | 1    | -    | 2    | 1    | -     | 2     | 2     | 1     |
| CO2                               | U24EC403.2 | 2    | 2    | 2    | 2                                                     | 2    | 1    | -    | 2    | 1    | -     | 2     | 2     | 1     |
| CO3                               | U24EC403.3 | 2    | 2    | 2    | 2                                                     | 2    | 1    | -    | 2    | 1    | -     | 2     | 2     | 1     |
| CO4                               | U24EC403.4 | 2    | 2    | 2    | 2                                                     | 2    | 1    | -    | 2    | 1    | -     | 2     | 2     | 1     |
| U24EC403                          |            | 2    | 2    | 2    | 2                                                     | 2    | 1    | -    | 2    | 1    | -     | 2     | 2     | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |      |                                                       |      |      |      |      |      |       |       |       |       |

# COMPUTER ORGANIZATION AND MICROPROCESSORS

|                                                                                                                                                                                                                                                   |                  |                    |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|------------|
| <b>Class:</b> B.Tech. IV -Semester                                                                                                                                                                                                                |                  | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                                                                                                                                                                                                                               | <b>U24EC404</b>  | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-O-E):</b>                                                                                                                                                                                                                    | <b>2-1-0-4-7</b> | <b>CIE :</b>       | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                            | <b>36 Hrs</b>    | <b>ESE :</b>       | <b>40%</b> |
| <b>Course Learning Objectives (LOs):</b>                                                                                                                                                                                                          |                  |                    |            |
| <i>This course will develop students' knowledge in /on...</i>                                                                                                                                                                                     |                  |                    |            |
| <b>LO1:</b> basic components of computers                                                                                                                                                                                                         |                  |                    |            |
| <b>LO2:</b> computer arithmetic and I/O organization                                                                                                                                                                                              |                  |                    |            |
| <b>LO3:</b> instruction sets, instruction formats and various addressing modes of 8086                                                                                                                                                            |                  |                    |            |
| <b>LO4:</b> the representation of data at the machine level and how computations are performed at machine level, develop assembly level programs to solve problems                                                                                |                  |                    |            |
| <b>UNIT-I</b>                                                                                                                                                                                                                                     |                  | <b>9 Hrs</b>       |            |
| <b>Digital Computers:</b> Introduction, Block diagram of digital computer, Definition of computer organization, Computer design and computer architecture                                                                                         |                  |                    |            |
| <b>Basic Computer Organization and Design:</b> Instruction codes, Computer registers, Computer instructions, Timing and control, Instruction cycle, Memory reference Instructions, Input – Output and interrupt, Complete computer description    |                  |                    |            |
| <b>Micro Programmed Control:</b> Control memory, Address sequencing, micro program example, Design of control unit                                                                                                                                |                  |                    |            |
| <i>Self Learning Topics (SLTs): Text1: Table 5.3,5.4,5.5,7.3, design of control unit (text 1: topic 7.4)</i>                                                                                                                                      |                  |                    |            |
| <b>UNIT-II</b>                                                                                                                                                                                                                                    |                  | <b>9 Hrs</b>       |            |
| <b>Computer Arithmetic:</b> Introduction, Addition and subtraction, Multiplication algorithms, Division algorithms, Floating - point arithmetic operations                                                                                        |                  |                    |            |
| <b>Input-Output Organization:</b> Peripheral devices, Input-Output interface, Asynchronous data transfer, Modes of Transfer, Priority interrupt, Direct memory access, Input –Output Processor (IOP), Intel 8089 IOP                              |                  |                    |            |
| <i>Self Learning Topics (SLTs): Peripheral Devices (text 1: topic 11.1), Direct memory Access, Input – Output Processor (IOP), Intel 8089 IOP (text 1: topic 11.6)</i>                                                                            |                  |                    |            |
| <b>UNIT-III</b>                                                                                                                                                                                                                                   |                  | <b>9 Hrs</b>       |            |
| <b>Central Processing Unit:</b> The 8086 Processor Architecture, Register organization, Physical memory organization, General Bus Operation, I/O Addressing Capability, Special Processor Activities, Minimum and Maximum mode system and timings |                  |                    |            |
| <b>8086 Instruction Set and Assembler Directives:</b> Machine language instruction formats, Addressing modes, Instruction set of 8086, Assembler directives and operators                                                                         |                  |                    |            |
| <i>Self Learning Topics (SLTs):Text 2: Special Processor Activities (topic 1.7)</i>                                                                                                                                                               |                  |                    |            |

| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 9 Hrs |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>Assembly Language Programming with 8086:</b> Machine level programs, Machine coding the programs, Programming with an assembler, Assembly Language example programs. Stack structure of 8086, Interrupts and Interrupt service routines, Interrupt cycle of 8086, Interrupt programming, Passing parameters to procedures, Macros, Timings and Delays                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| <b>Self Learning Topics (SLTs):</b> <i>Text 2: Ex:3.1,3.4,3.6,3.9,3.15,3.17,4.1,4.3 Prog:3.3,3.7,3.10,3.15,4.1,4.3,4.5.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
| <b>Course Learning Outcomes (COs):</b><br><i>After completion of this course, the students should be able to...</i><br><br><b>CO1:</b> interpret the basic components and examine the design of CPU, ALU and Control Unit<br><b>CO2:</b> appraise computer arithmetic & input-output organization<br><b>CO3:</b> adapt the architecture; make use of the instruction set, instruction formats and addressing modes of 8086<br><b>CO4:</b> develop assembly language programs to solve problems                                                                                                                                                                                                                                                                                                                                                       |       |
| <b><u>TextBook(s):</u></b> <ol style="list-style-type: none"> <li>1. M. Moris Mano, <i>Computer System Architecture</i>, 3rd ed. Pearson. (Chapters 5,6,7,10,11)</li> <li>2. K M Bhurchandi, A.K Ray ,<i>Advanced Microprocessors and Peripherals</i>, 3rd edition, McGraw Hill India Education Private Ltd (Chapters 1,2,3,4)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |
| <b><u>Reference Book(s):</u></b> <ol style="list-style-type: none"> <li>1. D V Hall, SSSP Rao, <i>Microprocessors and Interfacing</i>, 3rd ed. McGraw Hill India Education Private Ltd</li> <li>2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: <i>Computer Organization</i>, 5th ed. Tata McGraw Hill, 2002</li> <li>3. William Stallings, <i>Computer Organization and Architecture</i>, 9th ed. Pearson.</li> <li>4. David A. Patterson, John L. Hennessy: <i>Computer Organization and Design – The Hardware / Software Interface ARM Edition</i>, 4th ed. Elsevier, 2009</li> </ol>                                                                                                                                                                                                                                                             |       |
| <b><u>Web and Video link(s):</u></b> <ol style="list-style-type: none"> <li>1. <a href="https://archive.nptel.ac.in/courses/106/105/106105163">https://archive.nptel.ac.in/courses/106/105/106105163</a>NPTEL Video Lecture: 1 on Evolution of Computer Systems</li> <li>2. <a href="https://archive.nptel.ac.in/courses/108/103/108103157">https://archive.nptel.ac.in/courses/108/103/108103157</a>NPTEL Video Lecture: 3 on Functional Diagram of 8086</li> <li>3. <a href="https://archive.nptel.ac.in/courses/108/103/108103157">https://archive.nptel.ac.in/courses/108/103/108103157</a>NPTEL Video Lecture:14 on Programs on Subroutines</li> <li>4. <a href="https://archive.nptel.ac.in/courses/106/105/106105163">https://archive.nptel.ac.in/courses/106/105/106105163</a>NPTEL Video Lecture: 39 on FloatingPoint Arithmetic</li> </ol> |       |

| Course Articulation Matrix (CAM): |            |      |      |      | U24EC404 COMPUTER ORGANIZATION AND MICROPROCESSORS |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|----------------------------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                                               | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC404.1 | 2    | 2    | 1    | 1                                                  | -    | 1    | -    | 1    | 1    | -     | 1     | 1     | 2     |
| CO2                               | U24EC404.4 | 2    | 2    | 1    | 1                                                  | -    | 1    | -    | 1    | 1    | -     | 1     | 1     | 2     |
| CO3                               | U24EC404.2 | 2    | 2    | 1    | 1                                                  | -    | 1    | -    | 1    | 1    | -     | 1     | 1     | 2     |
| CO4                               | U24EC404.3 | 2    | 2    | 1    | 1                                                  | -    | 1    | -    | 1    | 1    | -     | 1     | 1     | 2     |
| U24EC404                          |            | 2    | 2    | 1    | 1                                                  | -    | 1    | -    | 1    | 1    | -     | 1     | 1     | 2     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |      |                                                    |      |      |      |      |      |       |       |       |       |

| PYTHON PROGRAMMING                                                                                                                                                                                                                                                                                                                        |           |            |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|-----|
| Class: B.Tech. IV -Semester                                                                                                                                                                                                                                                                                                               |           | Branch:ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                              | U24EC405  | Credits:   | 4   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                                                                   | 2-1-2-5-5 | CIE:       | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                           | 60 Hrs    | ESE:       | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                                                                                                                                         |           |            |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                                                                    |           |            |     |
| LO1: operators, control statements, functions and iterators of Python programming                                                                                                                                                                                                                                                         |           |            |     |
| LO2: namespaces, modules, collections, string handling methods and regular expressions                                                                                                                                                                                                                                                    |           |            |     |
| LO3: object-oriented programming, files and database connectivity                                                                                                                                                                                                                                                                         |           |            |     |
| LO4:numpy, pandas and matplotlib libraries of Python                                                                                                                                                                                                                                                                                      |           |            |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                                                                          |           |            |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                    |           | 9 Hrs      |     |
| Introduction: Features of Python, The future of Python, Writing and executing Python programs                                                                                                                                                                                                                                             |           |            |     |
| Python Preliminaries: Literal constants, Variables and identifiers, Data types, Input operation, Comments, Reserved words, Indentation, Operators, Expressions in Python, Type conversion                                                                                                                                                 |           |            |     |
| Decision Control Statements: Selection/Conditional branching statements, Loop structures/iterative statements, Nested loop, the continue statement, the pass statement                                                                                                                                                                    |           |            |     |
| Functions: Function definition, Function call, Variable scope and lifetime, the return statement, Advances in defining in functions, Lambda functions, Recursive functions, Lambda functions, Iterators, Decorators, Generators                                                                                                           |           |            |     |
| Self Learning Topics (SLTs): Installing Python, Testing and Debugging (Text1: Chapter 3 Anexure-1&2), Operator Precedence and Associativity (Text1: topic 3.12.10), The else statement used with loops (Text1: topic 4.8), Document Strings(Text1: topic 5.8)                                                                             |           |            |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                   |           | 9 Hrs      |     |
| Modules and Name Spaces: The from...import statement, Naming module, the dir() function, Packages in Python, Standard library modules, globals(), locals(), and reload(), Function redefinition                                                                                                                                           |           |            |     |
| Python Strings: String operations, String formatting operator, Built-in string methods and functions, slice operation, ord() and Chr() Functions, in and not in operators, Comparing strings, Regular expressions and Meta characters                                                                                                     |           |            |     |
| Data Structures: Lists, Tuple, Sets, Dictionaries, Comprehensions, High order functions                                                                                                                                                                                                                                                   |           |            |     |
| Self Learning Topics (SLTs): Standard library modules (Text1: topic 5.13), in & not in operator (Text1: topic 6.7), Variable-length Argument Tuples(Text1: topic 8.4.13), Thezip() Function (Text1: topic 8.4.14), String formatting with Dictionaries (Text1: topic 8.6.10)                                                              |           |            |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                  |           | 9 Hrs      |     |
| Python Object Oriented Programming: Classes and objects, Class method and self-argument, The __init__() method, Class variables and object variables, The __del__() method, Public and private data members, Private methods, Class methods, Static methods, Inheritance, Meat classes, Polymorphism, Operator overloading, Magic Methods |           |            |     |
| Error and Exception handling: Introduction to errors and exceptions, Handling exceptions, Multiple except blocks, Raising exception, Instantiating exceptions, Built-in and User-defined                                                                                                                                                  |           |            |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <p>Exceptions, The finally Block, Re-raising exceptions, Assertions, <i>Multi threading</i></p> <p><b>File Handling:</b> Opening and closing files, Reading and writing files, File positions, Renaming and deleting files, Directory methods</p> <p><b>Database Connectivity:</b> SQLite, creating a database table, Insert and retrieve data from database</p> <p><b>Self Learning Topics (SLTs):</b> <i>Calling class method from another class method (Text1: topics 9.10), Built in class variables (Text1: topic 9.12), Garbage Collection (Text1: topic 9.13), Complex objects (Text1: topic 10.4), Multiple Exceptions in a Single Block (Text1: topic 12.4), Handling exceptions in Invoked Function(Text1: topic 12.9)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>9 Hrs</b> |
| <p><b>NumPy:</b> The basics of NumPy arrays, Array indexing, Array slicing, Reshaping of array, Concatenation and splitting arrays, Aggregations, Universal Functions, Broad casting of Arrays</p> <p><b>Data Manipulation with Pandas:</b> Installing and using Pandas, Introducing Pandas objects, data indexing and selection, Handling missing data, Combining datasets, Merge and join, Aggregation and grouping, Vectorized String Operations, Working with Time Series</p> <p><b>Visualization with Matplotlib:</b> Importing Matplotlib, Saving figures to files, Simple line plots, Simple scatter plots, Histograms, Binnings, and density, Three-Dimensional Plotting in Matplotlib, Geographic Data with Basemap</p> <p><b>Self Learning Topics (SLTs):</b><i>Sorting array, Structured array operations (Text2: Chapter 2 topics), Rearranging Multi-Indices, Pivoting table (Text2: Chapter 3 topics), Visualizing errors, Density and Contour plots, Customizing color bars(Text2: Chapter 4 topics)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |
| <b>LABORATORY COMPONENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |              |
| <p><b>Experiment-I:</b></p> <ol style="list-style-type: none"> <li>1. Installation of Python and verifying PATH environment variable</li> <li>2. Running instructions in Interactive interpreter and a python script <ol style="list-style-type: none"> <li>a. Executing instructions in Python Interactive Interpreter</li> <li>b. Running python scripts in Command Prompt</li> <li>c. Running python scripts in IDLE</li> </ol> </li> <li>3. Develop a Python program to demonstrate importance of indentations. Purposefully raise indentation error and correct it</li> <li>4. Develop a Python program to take input text as command line argument and display it on screen</li> </ol> <p><b>Experiment-II</b></p> <ol style="list-style-type: none"> <li>1. Develop a Python program that takes 2 numbers as command line arguments and print its sum</li> <li>2. Develop a Python program to check whether the given number is even or odd</li> <li>3. Develop a Python program to calculate GCD of 2 numbers</li> <li>4. Develop a Python program to find Exponentiation (Power) of a number</li> <li>5. Develop a Python program to find given year is leap year or not</li> <li>6. Develop a Python program to develop a simple calculator</li> </ol> <p><b>Experiment-III</b></p> <ol style="list-style-type: none"> <li>1. Develop a Python program to find the Factorial of a given number</li> <li>2. Develop a Python program to find the Armstrong for a given number</li> </ol> |              |

3. Develop a Python program to take a number as input, and print countdown from that number to zero (use while loop)
4. Develop a Python program to demonstrate Iterators
5. Develop a Python program to demonstrate Decorators
6. Develop a Python program to demonstrate Generators

#### **Experiment-IV**

1. Develop a Python program to implement a module using import statement (Use python source file as a Module and implement import statement another python source files)
2. Develop a Python program to implement from, import statement
3. Develop a Python program to implement dir() function
4. Develop a Python program to demonstrate packages in python

#### **Experiment-V**

1. Develop a Python python program on strings for the following
  - a. To display substring in a string
  - b. To update an existing string
  - c. To implement string concatenation
  - d. To demonstrate string formatting operator
2. Develop a Python program to demonstrate use of slicing in strings
3. Develop a Python program to compare two strings
4. Reverse string and call this function for performing the operation)
5. Develop a Python program to demonstrate regular expression functions
6. Develop a Python program to demonstrate regular expressions using Meta characters

#### **Experiment-VI**

1. Develop a Python program to demonstrate list and related functions
2. Develop a Python program to demonstrate tuple and related functions
3. Develop a Python program to demonstrate set and related functions
4. Develop a Python program to demonstrate dictionaries
5. Develop a Python program to demonstrate comprehensions
6. Develop a Python program to demonstrate high order functions

#### **Experiment-VII**

1. Develop a python program to demonstrate classes and objects
2. Develop a python program to demonstrate class method
3. Develop a python program to demonstrate static method
4. Develop a python program to demonstrate inheritance
5. Develop a python program to demonstrate polymorphism
6. Develop a python program to demonstrate magic methods.

#### **Experiment-VIII**

1. Develop a python program to demonstrate multiple exception handling
2. Develop a python program to demonstrate multiple exception rising
3. Develop a python program to demonstrate multiple finally block
4. Develop a python program to demonstrate Assertions
5. Develop a python program on file operations for the following
  - a. To open and read data from a file
  - b. To write data into a file

- c. To compute number of characters, words, lines in a file

#### **Experiment-IX**

1. Develop a python programs to implement database connectivity
  - a. Install and verify SQLite Connector for Python
  - b. To connect check SQLite Database connectivity
  - c. To retrieve and display data from a table
  - d. To insert data into a table
  - e. To delete rows in a table

#### **Experiment-X**

1. Develop a Python program to demonstrate NumPy array
2. Develop a Python program to demonstrate Slice operation
3. Develop a Python program to demonstrate Reshaping of an array
4. Develop a Python program to demonstrate Ufunctions
5. Develop a Python program to demonstrate Broadcasting of numpy arrays
6. Develop a Python program to demonstrate Aggregate operations

#### **Experiment-XI**

1. Develop a Python pandas program to create a series from a ndarray
2. Develop a Python pandas program to create a series from input files
3. Develop a Python pandas program to demonstrate indexing and slicing data frames
4. Develop a Python pandas program to demonstrate handling missing values
5. Develop a Python pandas program to demonstrate vectorized string operations,
6. Develop a Python pandas program to demonstrate handling time series data

#### **Experiment-XII**

1. Develop a Python program to draw a simple line plot
2. Develop a Python program to draw a scatter plots
3. Develop a Python program to draw a histogram plot
4. Develop a Python program to draw a binning and density
5. Develop a Python program to demonstrate a three dimensional plotting
6. Develop a Python program to demonstrate a geographic basemap

#### **TextBook(s):**

1. Reema Thareja, *Python Programming using problem solving approach*, New Delhi: Oxford University Press, 2017 (Chapter 1 to 7)
2. Jake VanderPlas, *Python Data Science Handbook- Essential Tools for Working with Data*, 1st ed. California: O'Reilly Media, 2016 (Chapter 2 to 4)

#### **Reference Book(s):**

1. Dr. Charles R. Severance, *Python for Everybody-Exploring Data Using Python*, 1st ed. New Delhi: Shroff Publishers, 2016
2. David Beazley, *Python Cookbook*, 3rd ed. California: O'Reilly Media, Inc., 2013
3. Caleb Hattingh, *20 Python Libraries You Aren't Using*, 2nd ed. California: O'Reilly Media, 2016
4. Magnus Lie Hetland, *Beginning Python: from Novice to Professional*, 1st ed. New York: Apress, 2005

#### **Web and Video link(s):**

1. [https://onlinecourses.nptel.ac.in/noc23\\_cs99/](https://onlinecourses.nptel.ac.in/noc23_cs99/) NPTEL Video Lecture on Python For Data Science by Prof. Ragunathan Rengasamy, IIT Madras

2. [https://onlinecourses.nptel.ac.in/noc25\\_cs17](https://onlinecourses.nptel.ac.in/noc25_cs17)NPTEL Video Lecture on Data Analytics with Python By Prof. A Ramesh, IIT Roorkee
3. [https://onlinecourses.nptel.ac.in/noc25\\_cs69](https://onlinecourses.nptel.ac.in/noc25_cs69)/NPTEL Video Lecture on The Joy of Computing using Python By Prof. Sudarshan Iyengar, IIT Ropar

**Laboratory Manual (for laboratory component):**

1. *Python Programming Laboratory Manual and Record Book*, Department of CSE, KITSW

**Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to...*

**CO1:**develop python programs using control statements, operators and functions

**CO2:**apply collections, namespaces, packages, strings and regular expressions in application development

**CO3:**apply object-oriented programming principles in real-time problem solving

**CO4:**develop visualization graphs with Matplotlib and apply Numpy and Pandas libraries for dataanalysis

*(based on psychomotor skills acquired from laboratory component)*

**CO5:**implement and test python programs using operators, control statements &functions

**CO6:**Implement and test python packages using string handling methods, regular expressions, and collections

**CO7:**implement and test object oriented paradigms and database operations in Python programming

**CO8:**build visualization graphs with Matplotlib and adapt packages like Numpy, Pandas for data analysis

| Course Articulation Matrix (CAM): |            |         |         |         |         |         | U24EC405 PYTHON PROGRAMMING |         |         |         |          |          |          |          |
|-----------------------------------|------------|---------|---------|---------|---------|---------|-----------------------------|---------|---------|---------|----------|----------|----------|----------|
| CO                                |            | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6                     | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 |
| CO1                               | U24EC405.1 | 1       | 2       | 2       | 2       | 2       | 1                           | -       | -       | -       | 1        | 1        | 2        | 2        |
| CO2                               | U24EC405.2 | 2       | 2       | 2       | 2       | 2       | 1                           | -       | -       | -       | 1        | 1        | 2        | 2        |
| CO3                               | U24EC405.3 | 2       | 2       | 2       | 2       | 3       | 1                           | -       | -       | -       | 1        | 1        | 2        | 2        |
| CO4                               | U24EC405.4 | 2       | 2       | 2       | 2       | 3       | 1                           | -       | -       | -       | 1        | 1        | 2        | 2        |
| CO5                               | U24EC405.5 | 1       | 2       | 2       | 2       | 2       | 1                           | 1       | 1       | 1       | 1        | 2        | 2        | 2        |
| CO6                               | U24EC405.6 | 2       | 2       | 2       | 2       | 2       | 1                           | 1       | 1       | 1       | 1        | 2        | 2        | 2        |
| CO7                               | U24EC405.7 | 2       | 2       | 2       | 2       | 3       | 1                           | 1       | 1       | 1       | 1        | 2        | 2        | 2        |
| CO8                               | U24EC405.8 | 2       | 2       | 2       | 2       | 3       | 1                           | 1       | 1       | 1       | 1        | 2        | 2        | 2        |
| U24EC405                          |            | 1.75    | 2       | 2       | 2       | 2       | 1                           | 1       | 1       | 1       | 1        | 1.5      | 2        | 2        |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |         |         |         |         |         |                             |         |         |         |          |          |          |          |

| <b>SOFT AND INTERPERSONAL SKILLS LABORATORY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |                                       |              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------|--------------|
| <b>Class:</b> B.Tech.III -Semester& IV-Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  | <b>Branch:</b> Common to all Branches |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>U24VA306B</b> | <b>Credits:</b>                       | <b>1</b>     |
| <b>Hours/Week (L-T-P-O-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>0-0-2-2-4</b> | <b>CIE:</b>                           | <b>100 %</b> |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>24Hrs</b>     | <b>ESE:</b>                           | <b>-</b>     |
| <p><b>Course Learning Objectives (LOs):</b></p> <p><i>This course will develop students' knowledge in /on...</i></p> <p><b>LO1:</b>analysing self and learning to overcome possible threats</p> <p><b>LO2:</b> group dynamics to demonstrate respect for the opinions and beliefs of group</p> <p><b>LO3:</b> effective presentations using visual aids and analyzing the videos</p> <p><b>LO4:</b> communicating professionally, making resume in line with industry expectations</p>                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                                       |              |
| <p><b><u>LIST OF ACTIVITIES</u></b></p> <p><b>Activity 1:</b> Ice-breaking, Self-Awareness and Just a Minute (JAM)</p> <p><b>Activity 2:</b> Self-Introduction &amp;Personal SWOT Analysis</p> <p><b>Activity 3:</b> Reading Comprehension &amp; Critical Thinking</p> <p><b>Activity 4:</b> Active Listening &amp; Non-Verbal Observation (Video + Peer Practice)</p> <p><b>Activity 5:</b> Group Discussion - 1</p> <p><b>Activity 6:</b> Resume Building &amp;LinkedIn Profile Review</p> <p><b>Activity 7:</b> Group Discussion - 2</p> <p><b>Activity 8:</b> Presentation Skills with PPT / Storytelling</p> <p><b>Activity 9:</b> Group Discussion - 3</p> <p><b>Activity 10:</b> Mock Interviews: Technical &amp; HR</p> <p><b>Activity 11:</b> Email Etiquette &amp;Professional Communication</p> <p><b>Activity 12:</b> Workplace Etiquette &amp; Conflict Resolution</p>                                      |                  |                                       |              |
| <p><b>Course Learning Outcomes (COs):</b></p> <p><i>After completion of this course, the students should be able to...</i></p> <p><b>CO1:</b> deliver concise &amp; effective self-introduction and demonstrate confidence, spontaneous speaking skills within a limited time</p> <p><b>CO2:</b> conduct a personal SWOT analysis to identify areas for self-improvement and career development</p> <p><b>CO3:</b> demonstrate clear &amp; respectful communication, leadership, positive attitude and improve interpersonal relationship by actively participating in group discussions, collaborative tasks &amp; mock interviews</p> <p><b>CO4:</b> create a professional resume, develop a LinkedIn profile and demonstrate effective video communication by making effective videos on self-introduction, personal SWOT analysis &amp; spontaneous speaking activity along with email &amp; workplace etiquette</p> |                  |                                       |              |
| <p><b><u>TextBook(s):</u></b></p> <p>1. Krishna Mohan &amp;MeeraBenerji, <i>Developing Communications Skills</i>, 2nd ed., New Delhi: Mcmillan Publications, 2005</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                                       |              |

| Course Articulation Matrix (CAM): |              |      | U24VA406B SOFT AND INTERPERSONAL SKILLS LABORATORY |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|--------------|------|----------------------------------------------------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |              | PO 1 | PO 2                                               | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24VA406B .1 | -    | -                                                  | -    | -    | -    | -    | -    | 2    | 3    | -     | 1     | -     | -     |
| CO2                               | U24VA406B .2 | -    | -                                                  | -    | -    | -    | -    | 2    | 3    | 3    | -     | 1     | -     | -     |
| CO3                               | U24VA406B .3 | -    | -                                                  | -    | -    | -    | -    | -    | 2    | 3    | -     | 1     | -     | -     |
| CO4                               | U24VA406B .4 | -    | -                                                  | -    | -    | -    | -    | 1    | 2    | 3    | -     | 1     | -     | -     |
| U24VA406B                         |              | -    | -                                                  | -    | -    | -    | -    | 1.5  | 2.25 | 3    | -     | 1     | -     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |              |      |                                                    |      |      |      |      |      |      |      |       |       |       |       |

| ENVIRONMENTAL STUDIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |            |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|------|
| Class:B.Tech.IV Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           | Branch:ECE |      |
| CourseCode:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | U24CY411* | Credits:   | 0    |
| Hours/Week(L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2-0-0-5-7 | CIE:       | 60%  |
| TotalNumberofTeachingHours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 24Hrs     | ESE:       | 40%  |
| <b>CourseLearningObjectives(LOs):</b><br><i>This course will develop students' knowledge in/on...</i><br><b>LO1:</b> natural resources and their usage more equitably<br><b>LO2:</b> ecosystem and the importance of biodiversity conservation<br><b>LO3:</b> environmental pollution and its control measures<br><b>LO4:</b> environmental legislation and green methodology                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |            |      |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           |            | 6Hrs |
| <b>The Multidisciplinary Nature of Environmental Studies:</b> Definition, Scope and importance<br><b>Natural Resources:</b> Forest Resources-Use and over exploitation of forests, Deforestation, Timber extraction, Mining, Dams and their effects on forests and tribal people; Water Resources-Use and over-utilization of surface and ground water, Floods, Drought, Conflicts over water; Mineral Resources-Environmental effects of extracting and using mineral resources; Energy Resources-Renewable and non-renewable energy sources, Use of alternate energy sources<br><br><i>Self Learning Topics (SLTs): Use and over-utilization of surface and ground water (Text1: unit 2, topic: 2.2.2) world food problems (Text1: unit 2, topic 2.2.2)</i>                                                                   |           |            |      |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |            | 6Hrs |
| <b>Ecosystem and Biodiversity:</b><br><b>Ecosystem:</b> Concepts of an ecosystem, Food chain, Food webs, Ecological pyramids, Energy flow in the ecosystem and ecological succession<br><br><b>Biodiversity and its Conservation:</b> Introduction, Definition, Genetic, Species and ecosystem diversity, Value of biodiversity, Biodiversity in India, Hot spots of biodiversity, Man-wildlife conflicts, Endangered and endemic species of India; In-situ and Ex-situ conservation<br><br><i>Self Learning Topics (SLTs): Introduction and definition of biodiversity (Text1: unit 4, topic 4.1)</i>                                                                                                                                                                                                                          |           |            |      |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |            | 6Hrs |
| <b>Environmental Pollution:</b> Global issues-Global climatic change, Greenhouse gases, Effects of global warming, Ozone layer depletion<br><b>International Conventions/Protocols:</b> Earth summit, Kyoto protocol, Montreal protocol<br><b>Environmental Pollution-</b> Causes and effects of air, Water, Soil, Marine and noise pollution with case studies<br><b>Solid and Hazardous Waste Management:</b> Introduction, Types, Effects of urban industrial and nuclear waste<br><b>Natural Disaster Management:</b> Introduction to disaster, Management of disaster, Disaster management of flood, earthquake, cyclone and landslides<br>Role of information technology in environment and human health<br><i>Self Learning Topics (SLTs): Role of individual in prevention of pollution (Text1: unit 5, topic 5.10)</i> |           |            |      |

| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 6Hrs |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <p><b>Social Issues and the Environment:</b> Role of Individual and Society, Water conservation, Rain water harvesting</p> <p><b>Environmental Protection/Control Acts:</b> Air (prevention and control of pollution) act 1981, Forest conservation act (1980 and 1992), Wildlife protection act 1972, Environment protection act 1986, Issues involved in enforcement of environmental legislations</p> <p><b>Green Methodology:</b> Principles of green chemistry, Green methods in electronic production, Impact of electronic waste on public health and environment</p> <p><b>The Sustainable Development Goals (SDGs):</b> United Nations Sustainable Development Goals</p> <p><b>Self Learning Topics (SLTs):</b> Water (prevention and control of pollution) act 1974 (Text 1: unit 6, topics 6.10), Water pollution cess act 1977 (Text 1: unit 6, topics 6.11)</p> |      |
| <p><b>Text Book(s):</b></p> <ol style="list-style-type: none"> <li>1. Erach Bharucha, <i>Text Book of Environmental Studies for Under Graduate Courses</i>, 2<sup>nd</sup> Edn., Universities Press (India) Pvt. Ltd, 2013</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |
| <p><b>Reference Book(s):</b></p> <ol style="list-style-type: none"> <li>1. Y. Anjaneyulu, <i>Introduction to Environmental Science</i>, B.S. Publications, 2004.</li> <li>2. Gilbert M. Masters, <i>Introduction to Environmental Engineering &amp; Science</i>, 3<sup>rd</sup> Edn., Prentice Hall of India, 1991</li> <li>3. Anubha Kaushik, C.P. Kaushik, <i>Environmental Studies</i>, 4<sup>th</sup> Edn., New Age International Publishers, 2014</li> <li>4. R. Rajagopalan, <i>Environmental Studies from crisis to cure</i>, Oxford University Press, 2<sup>nd</sup> Edn., 2011</li> </ol>                                                                                                                                                                                                                                                                           |      |
| <p><b>Web and Video link(s):</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/">https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/</a> video lecture on renewable energy resources by Prof. Vaibhav. V. Goud and Dr. R. Anandalakshmi, Dept. Of Chemical Engineering, Guwahati.</li> <li>2. <a href="https://sdgs.un.org/goals">https://sdgs.un.org/goals</a>; UN's webpage on 17 sustainable Development Goals</li> <li>3. <a href="https://onlinecourses.nptel.ac.in/noc23_hs57/preview">https://onlinecourses.nptel.ac.in/noc23_hs57/preview</a>; United nations Sustainable Development Goals</li> </ol>                                                                                                                                                                             |      |
| <p><b>Course Learning Outcomes (COs):</b></p> <p>After completion of this course, the student should be able to,</p> <p><b>CO1:</b> identify the natural resources and practice their usage more equitably</p> <p><b>CO2:</b> develop an action plan for sustainable alternatives and conserving biodiversity</p> <p><b>CO3:</b> examine and perceive the solutions for the environmental pollution</p> <p><b>CO4:</b> adapt issues involved in enforcement of environmental legislation and green methodology</p>                                                                                                                                                                                                                                                                                                                                                           |      |

| Course Articulation Matrix (CAM): |             |         |         |         | U24CY411* ENVIRONMENTAL STUDIES |         |         |         |         |         |          |          |          |          |
|-----------------------------------|-------------|---------|---------|---------|---------------------------------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO                                |             | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4                         | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO<br>10 | PO<br>11 | PSO<br>1 | PSO<br>2 |
| CO1                               | U24CY411.1  | 2       | 1       | 2       | 1                               | -       | 2       | 1       | 1       | 1       | -        | -        | -        | -        |
| CO2                               | U24CY411.2  | -       | -       | 2       | -                               | -       | 1       | 1       | 1       | 1       | 1        | -        | -        | -        |
| CO3                               | U24CY411.3  | 1       | 2       | 1       | -                               | -       | 1       | 1       | 1       | 1       | 1        | 1        | -        | -        |
| CO4                               | U24CY2411.4 | -       | -       | 1       | -                               | -       | 1       | 1       | 1       | 1       | -        | 1        | -        | -        |
| U24CY4--                          |             | 1.50    | 1.50    | 1.50    | 1.00                            | -       | 1.25    | 1.00    | 1.00    | 1.00    | 1.00     | 1.00     | -        | -        |

# 2<sup>nd</sup> Year Exit Courses Syllabus

### **Bridge Courses for exit:**

Successful completion of two subjects (6-Credits) during 2-months internship at the institute

OR

Successful completion of two suitable skill based courses (external) to qualify for Certification

### **B. After Second Year: (UG Diploma in ECE)**

- (i) The candidate should pass any two of the following additional courses (Diploma Level) during the 2-Months internship at institute

| Exit Option to Qualify <b>UG Diploma in ECE</b> : Any Two (02) Courses during the 2 - Months internship |          |             |                                                    |   |   |   |   |   |   |
|---------------------------------------------------------------------------------------------------------|----------|-------------|----------------------------------------------------|---|---|---|---|---|---|
| S. No.                                                                                                  | Category | Course Code | Course Title                                       | L | T | P | O | E | C |
| 1                                                                                                       | PCC      | U24EC412X   | Basic Embedded Systems                             | 2 | - | 2 | - | 4 | 3 |
| 2                                                                                                       | PCC      | U24EC413X   | Fundamentals of IoT (Internet of Things)           | 2 | - | 2 | - | 4 | 3 |
| 3                                                                                                       | PCC      | U24EC414X   | VLSI Design, Tools & Technology                    | 2 | - | 2 | - | 4 | 3 |
| 4                                                                                                       | PCC      | U24EC415X   | Any other course approved by BoS Chair and Dean AA | 2 | - | 2 | - | 4 | 3 |

(OR)

- (ii) Any two suitable skill-based courses to qualify for Diploma.

| Exit Option to Qualify <b>UG Diploma in ECE</b> : Any Two (02) Skill based Courses :- |          |             |                                                                                                                                                                                                                                                                                                                                     |   |   |   |   |   |   |
|---------------------------------------------------------------------------------------|----------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|
| S. No.                                                                                | Category | Course Code | Course Title                                                                                                                                                                                                                                                                                                                        | L | T | P | O | E | C |
| 1                                                                                     | SEC      | U24SE412X   | Digital Cable TV Technician<br><a href="https://www.essc-india.org/images/QPs/Digital%20Cable%20Technician%20-%20Access%20-%20ELE_Q8106_v4.0.pdf">https://www.essc-india.org/images/QPs/Digital%20Cable%20Technician%20-%20Access%20-%20ELE_Q8106_v4.0.pdf</a>                                                                      | - | - | 6 | - | 6 | 3 |
| 2                                                                                     | SEC      | U24SE413X   | Arduino Based Embedded System Design<br><a href="https://www.nielit.gov.in/sites/default/files/headquarter/Certificate%20Course%20in%20ARDUINO%20based%20Embedded%20System%20Design.pdf">https://www.nielit.gov.in/sites/default/files/headquarter/Certificate%20Course%20in%20ARDUINO%20based%20Embedded%20System%20Design.pdf</a> | - | - | 6 | - | 6 | 3 |
| 3                                                                                     | SEC      | U24SE414X   | VLSI Design using EDA Tools                                                                                                                                                                                                                                                                                                         | - | - | 6 | - | 6 | 3 |

|   |     |           |                                                                                                                                                                                                                                          |   |   |   |   |   |   |
|---|-----|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|
|   |     |           | <a href="https://www.nielit.gov.in/sites/default/files/Delhi/VLSI%20DESIGN%20AND%20TOOL.pdf">https://www.nielit.gov.in/sites/default/files/Delhi/VLSI%20DESIGN%20AND%20TOOL.pdf</a>                                                      |   |   |   |   |   |   |
| 4 | SEC | U24SE415X | Optical fiber Technician <a href="https://rajshaladarpan.nic.in/sd2/Home/Public2/VocationalSchool/Curriculum/11th_12th_Telecom.pdf">https://rajshaladarpan.nic.in/sd2/Home/Public2/VocationalSchool/Curriculum/11th_12th_Telecom.pdf</a> | - | - | 6 | - | 6 | 3 |
| 5 | SEC | U24SE416X | Any other skill based course approved by BoS Chair and Dean AA                                                                                                                                                                           | - | - | 6 | - | 6 | 3 |

#### **B. Tech Honours with Research:**

Students opting for B. Tech Honours with Research, shall undergo a 2-Month Mandatory Research Internship-I (5 Credits) at respective department during the summer vacation after IV Semester.

| BASIC EMBEDDED SYSTEMS                                                                                                                                                                                                                                                                                                                                                                             |           |            |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|-----|
| Class:B.Tech.IV–Semester(Exitcourse)                                                                                                                                                                                                                                                                                                                                                               |           | Branch:ECE |     |
| CourseCode:                                                                                                                                                                                                                                                                                                                                                                                        | U24EC412X | Credits:   | 3   |
| Hours/Week(L-T-P-O-E):                                                                                                                                                                                                                                                                                                                                                                             | 2-0-2-0-4 | CIE:       | 60% |
| TotalNumberofTeachingHours:                                                                                                                                                                                                                                                                                                                                                                        | 32 Hrs    | ESE:       | 40% |
| LearningObjectives(LOs):<br>Thiscoursewilldevelopstudents'knowledgein/on...<br>LO1: Understand the fundamentals and architecture of embedded systems<br>LO2: Analyse hardware and software components of embedded systems<br>LO3: Design simple embedded systems using microcontrollers and interfacing techniques<br>LO4: Develop embedded applications and implement real-time operating systems |           |            |     |
| THEORYCOMPONENT                                                                                                                                                                                                                                                                                                                                                                                    |           |            |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                             |           | 4Hrs       |     |
| Unit 1: Introduction to Embedded Systems: Definition and Characteristics of Embedded Systems, Applications of Embedded Systems, Embedded System Architecture: Harvard and Von Neumann Architectures, Basic Components: Sensors, Actuators, and Peripherals                                                                                                                                         |           |            |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                            |           | 4Hrs       |     |
| Microcontrollers and Interfacing: Introduction to Microcontrollers: 8051, AVR, ARM, Memory Organization and I/O Ports, Interfacing Sensors and Actuators, ADC/DAC Conversions and Serial Communication (UART, SPI, I2C)                                                                                                                                                                            |           |            |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                           |           | 4Hrs       |     |
| Embedded Software Development:Embedded C Programming: Variables, Functions, and Pointers, Cross Compilation and Debugging, Real-Time Operating Systems (RTOS): Concepts and Scheduling, Interrupts and Timers                                                                                                                                                                                      |           |            |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                            |           | 4Hrs       |     |
| Embedded System Design and Applications: Designing a Simple Embedded System: Case Studies (e.g., Automatic Door Control, Temperature Monitoring System), Power Management and Energy Efficiency, Communication Protocols: CAN, Zigbee, Bluetooth, Security Aspects in Embedded Systems                                                                                                             |           |            |     |

## LABORATORY COMPONENT

### List of Experiments:

1. Introduction to Arduino Boards, pin description and basic functions of Arduino
2. Design an embedded system to monitor the room temperature using LM35 and display it on serial monitor
3. Design an embedded system to monitor light intensity and if light intensity >512 lux turn ON the LED, otherwise Turn OFF the LED
4. Design an embedded system to find distance of an object and display it on LCD
5. Design an embedded system to turn ON Buzzer if person is detected
6. Design an embedded system to control the direction of DC motor using serial port
7. Design a weather monitoring system
8. Design a home automation system (Note: you can use different sensors and different appliances)

### Text Book(s):

1. Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, McGraw Hill Education
2. Shibu K. V, *Introduction to Embedded Systems*, McGraw Hill Education

### Reference Book(s):

1. Frank Vahid and Tony Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley
2. David E. Simon, *An Embedded Software Primer*, Addison-Wesley

### Laboratory Manual (for laboratory component):

1. Fundamentals of IoT laboratory manual and Record Book, Department of ECE, KITSW

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to...*

**CO1:** Explain the architecture and components of embedded systems

**CO2:** Demonstrate knowledge of microcontrollers and interfacing

**CO3:** Design simple embedded systems using hardware and software tools

**CO4:** Implement real-time embedded applications and operating systems

*(based on psychomotor skills acquired from laboratory component)*

**CO5:** Demonstrate the ability to use Arduino for embedded system development and interface various sensors and actuators

**CO6:** Implement real-time monitoring systems for environmental parameters like temperature, light intensity, and distance

**CO7:** Develop automation applications such as buzzer activation, DC motor control, and home automation

**CO8:** Analyze and design IoT-based embedded systems for smart applications like weather monitoring and home automation

| Course Articulation Matrix (CAM): |             |     |      |      |      |      | U24EC412X BASIC EMBEDDED SYSTEMS |      |      |      |      |      |      |      |
|-----------------------------------|-------------|-----|------|------|------|------|----------------------------------|------|------|------|------|------|------|------|
| CO                                |             | PO1 | PO2  | PO3  | PO4  | PO5  | PO6                              | PO7  | PO8  | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC412X.1 | 3   | 2    | -    | -    | -    | -                                | -    | -    | -    | -    | 1    | 3    | 2    |
| CO2                               | U24EC412X.2 | 3   | 3    | 2    | -    | 3    | -                                | -    | -    | -    | -    | 1    | 3    | 3    |
| CO3                               | U24EC412X.3 | 3   | 2    | 3    | 2    | 3    | 1                                | -    | 2    | 2    | 2    | 2    | 3    | 3    |
| CO4                               | U24EC412X.4 | 3   | 2    | 3    | 3    | 3    | 2                                | 1    | 2    | 2    | 2    | 1    | 3    | 3    |
| CO5                               | U24EC412X.5 | 3   | 2    | 2    | 2    | 3    | 1                                |      | 2    | 2    | 2    | 2    | 3    | 2    |
| CO6                               | U24EC412X.6 | 3   | 2    | 3    | 3    | 3    | 2                                | 1    | 2    | 2    | 2    | 3    | 3    | 3    |
| CO7                               | U24EC412X.7 | 3   | 2    | 3    | 2    | 3    | 2                                | 1    | 2    | 2    | 2    | 2    | 3    | 3    |
| CO8                               | U24EC412X.8 | 3   | 3    | 3    | 3    | 3    | 3                                | 2    | 3    | 2    | 3    | 3    | 3    | 3    |
| U24EC412X                         |             | 3   | 2.25 | 2.71 | 2.50 | 3.00 | 1.83                             | 1.25 | 2.17 | 2.00 | 2.17 | 1.88 | 3.00 | 2.75 |

| FUNDAMENTALS of IoT (INTERNET of THINGS)                                                                                                                                                                                                                                                  |           |             |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-----|
| Class: B.Tech. IV –Semester (Exit course)                                                                                                                                                                                                                                                 |           | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                              | U24EC413X | Credits     | 3   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                                                                                   | 2-0-2-0-4 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                           | 32 Hrs    | ESE:        | 40% |
| Learning Objectives (LOs):                                                                                                                                                                                                                                                                |           |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                                                                                    |           |             |     |
| LO1: fundamentals of IoT, IoT characteristics, sensors & actuators, and domain specific applications                                                                                                                                                                                      |           |             |     |
| LO2: IoT devices and its interfacing with Raspberry Pi                                                                                                                                                                                                                                    |           |             |     |
| LO3: IoT communication, data link, network, transport, and application layer protocols                                                                                                                                                                                                    |           |             |     |
| LO4: IoT software platforms, cloud, edge and fog computing                                                                                                                                                                                                                                |           |             |     |
| THEORY COMPONENT                                                                                                                                                                                                                                                                          |           |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                    |           | 4 Hrs       |     |
| Basics of Internet of Things (IoT): Introduction to IoT, Characteristics of IoT; Principles: Sensors and Actuators-characteristics, applications; Domain Specific IoT Applications: Home automation, industrial automation, smart cities, healthcare and agriculture                      |           |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                   |           | 4 Hrs       |     |
| IoT devices and interfacing: Introduction to IoT Devices, Raspberry Pi; Raspberry Pi interfaces-Inter Integrated Circuits (I2C), Serial Peripheral Interfacing (SPI), UART; Interfacing sensors and actuators, Connecting Raspberry Pi to cloud platform-Data Analytics and visualization |           |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                  |           | 4 Hrs       |     |
| IoT Protocols-Communication protocols, Data link layer Protocols, network layer Protocols, transport layer Protocols, and Application Layer Protocols                                                                                                                                     |           |             |     |
| UNIT-IV                                                                                                                                                                                                                                                                                   |           | 4 Hrs       |     |
| IoT Software Platforms, Cloud Computing, Edge Computing and Fog Computing                                                                                                                                                                                                                 |           |             |     |
| LABORATORY COMPONENT                                                                                                                                                                                                                                                                      |           |             |     |
| List of Experiments                                                                                                                                                                                                                                                                       |           |             |     |
| 1. Demonstration of Sensors, Actuators, and Setting Up Raspberry Pi and Installing OS                                                                                                                                                                                                     |           |             |     |
| 2. Controlling an LED using Raspberry Pi (GPIO Programming)                                                                                                                                                                                                                               |           |             |     |
| 3. Interfacing Sensors with Raspberry Pi                                                                                                                                                                                                                                                  |           |             |     |
| 4. Interfacing Actuators with Raspberry Pi                                                                                                                                                                                                                                                |           |             |     |
| 5. Cloud Connectivity with Raspberry Pi                                                                                                                                                                                                                                                   |           |             |     |
| 6. Implement MQTT/CoAP Protocol with Raspberry Pi for data transmission and reception                                                                                                                                                                                                     |           |             |     |
| 7. Implement Communication protocols with Raspberry Pi for an IoT applications                                                                                                                                                                                                            |           |             |     |
| TextBook(s):                                                                                                                                                                                                                                                                              |           |             |     |
| 1. Arshdeep Bahga and Vijay Madisetti, <i>Internet of Things: A Hands-on Approach</i> , Universities Press.                                                                                                                                                                               |           |             |     |
| 2. Bharat Bhushan, Bhuvan Unhelkar, <i>Internet of Things (IoT): Principles, Paradigms and Applications of IoT</i> , Springer.                                                                                                                                                            |           |             |     |
| 3. Peter Waher, <i>Mastering Internet of Things: Design and create your own IoT applications using</i>                                                                                                                                                                                    |           |             |     |

Raspberry Pi 3, Packt Publishing.

**Reference Book(s):**

1. Raj Kamal, *Internet of Things: Architecture and Design Principles*, McGraw Hill Education.
2. Peter Waher, *Learning Internet of Things*, Packt Publishing, 2015.

**Resources:** <https://azure.microsoft.com/en-us/solutions/iot/iot-technology-protocols>

**Laboratory Manual (for laboratory component):**

1. *Fundamentals of IoT laboratory manual and Record Book*, Department of ECE, KITSW

**Course Learning Outcomes (COs)**

*After completion of this course, the students should be able to...*

**CO1:** describe IoT characteristics, applications of IoT along with the functioning of sensors, and actuators

**CO2:** develop IoT systems using Raspberry Pi, interfacing sensors & actuators, and cloud integration

**CO3:** analyze various IoT communication, data link, network, transport, and application layer protocols

**CO4:** elaborate IoT software platforms, cloud platforms, and perform data analytics to build and evaluate IoT applications.

*(based on psychomotor skills acquired from laboratory component)*

**CO5:** examine the setup & OS configuration of Raspberry Pi along with a sensor or an actuator interfacing

**CO6:** develop GPIO programming using Raspberry Pi with IoT devices, sensors & actuators

**CO7:** Integrate an IoT device with Raspberry Pi using MQTT/CoAP protocols for data transmission and reception

**CO8:** realize Communication protocols like Wi-Fi, Bluetooth, and Zigbee for an IoT applications

| Course Articulation Matrix (CAM): |             | U24EC413X FUNDAMENTALS OF IoT (INTERNET OF THINGS) |       |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|----------------------------------------------------|-------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1                                               | PO 2  | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC413X.1 | 3                                                  | 3     | 3    | 2    | 2    | 3    | 3    | 2    | 2    | 2     | 2     | 2     | 3     |
| CO2                               | U24EC413X.2 | 3                                                  | 3     | 3    | 2    | 3    | 3    | 3    | 2    | 2    | 2     | 3     | 2     | 3     |
| CO3                               | U24EC413X.3 | 3                                                  | 2     | 2    | 2    | 2    | 2    | 2    | 1    | 1    | 2     | -     | 2     | 3     |
| CO4                               | U24EC413X.4 | 3                                                  | 2     | 2    | 2    | 2    | 3    | 3    | 2    | 1    | 2     | -     | 2     | 3     |
| CO5                               | U24EC413X.5 | 3                                                  | 2     | 3    | 1    | 3    | 2    | 2    | 2    | 3    | 3     | 3     | 2     | 3     |
| CO6                               | U24EC413X.6 | 3                                                  | 3     | 3    | 2    | 3    | 3    | 3    | 2    | 3    | 3     | 3     | 2     | 3     |
| CO7                               | U24EC413X.7 | 3                                                  | 2     | 3    | 2    | 3    | 2    | 2    | 1    | 3    | 3     | 3     | 2     | 3     |
| CO8                               | U24EC413X.8 | 3                                                  | 2     | 3    | 2    | 3    | 2    | 2    | 1    | 3    | 3     | 3     | 2     | 3     |
| U24EC413X                         |             | 3                                                  | 2.375 | 2.75 | 1.8  | 2.5  | 2.5  | 2.5  | 1.6  | 2.25 | 2.5   | 2.1   | 2     | 3     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |                                                    |       |      |      |      |      |      |      |      |       |       |       |       |

| VLSI DESIGN TOOLS AND TECHNOLOGY                                                                                                                                                                                        |            |             |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|-----|
| Class: B.Tech. IV -Semester                                                                                                                                                                                             |            | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                            | U24EC414X  | Credits:    | 3   |
| Hours/Week (L-T-P-O-E):                                                                                                                                                                                                 | 2-1-2-5-10 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                         | 32 Hrs     | ESE:        | 40% |
| Course Learning Objectives (LOs):                                                                                                                                                                                       |            |             |     |
| This course will develop students' knowledge in /on...                                                                                                                                                                  |            |             |     |
| LO1:fundamentals of VLSI design and fabrication                                                                                                                                                                         |            |             |     |
| LO2:MOS circuit design, layout techniques, and scaling limitations                                                                                                                                                      |            |             |     |
| LO3:VHDL programming for digital circuit design                                                                                                                                                                         |            |             |     |
| LO4:EDA tools for circuit simulation, synthesis, and layout                                                                                                                                                             |            |             |     |
| THEORY COMPONENT                                                                                                                                                                                                        |            |             |     |
| UNIT-I                                                                                                                                                                                                                  |            | 4Hrs        |     |
| Introduction to VLSI Design and Technology: Evolution of VLSI technology and Moore's Law, Basic MOS transistor, IC fabrication process: NMOS and CMOS, CMOS inverter characteristics                                    |            |             |     |
| UNIT-II                                                                                                                                                                                                                 |            | 4Hrs        |     |
| MOS Circuit Design Processes: MOS layers, Stick diagrams and symbolic diagrams, NMOS design style, CMOS design style, Layout, Lambda based design rules, Layout diagrams, Scaling parameters and Limitations of scaling |            |             |     |
| UNIT-III                                                                                                                                                                                                                |            | 4Hrs        |     |
| Basics of VHDL: Introduction to VHDL, Need for HDL, VHDL vs. Verilog. Entity, Architecture, Configuration                                                                                                               |            |             |     |
| Data Types & Operators in VHDL                                                                                                                                                                                          |            |             |     |
| Modeling Styles in VHDL: Behavioral, Dataflow, and Structural modeling                                                                                                                                                  |            |             |     |
| Combinational and sequential circuit design using VHDL                                                                                                                                                                  |            |             |     |
| UNIT-IV                                                                                                                                                                                                                 |            | 4Hrs        |     |
| Overview of EDA Tools: Importance of different categories of toolsin VLSI design.                                                                                                                                       |            |             |     |
| Schematic Capture & Circuit Simulation Tools: SPICE, Cadence Virtuoso.                                                                                                                                                  |            |             |     |
| Hardware Description Language (HDL) Tools: Model Sim, Xilinx Vivado.                                                                                                                                                    |            |             |     |
| Physical Design and Layout Tools: Cadence Encounter, Synopsys IC Compiler                                                                                                                                               |            |             |     |
| FPGA Design Tools: Intel Quartus, Xilinx ISE/Vivado.                                                                                                                                                                    |            |             |     |
| LABORATORY COMPONENT                                                                                                                                                                                                    |            |             |     |
| List of Experiments                                                                                                                                                                                                     |            |             |     |
| 1. Design and simulation of Logic gates using VHDL                                                                                                                                                                      |            |             |     |
| 2. Design and simulation of Full Addder using VHDL                                                                                                                                                                      |            |             |     |
| 3. Design and simulation of Flip flops (JK, T, D) using VHDL                                                                                                                                                            |            |             |     |
| 4. Design and simulation of 4-Bit Ring counter and johnson counter using VHDL                                                                                                                                           |            |             |     |
| 5. Transfer Characteristics of CMOS inverter                                                                                                                                                                            |            |             |     |
| 6. Design and analysis of Universal Logic Gates Using CMOS                                                                                                                                                              |            |             |     |
| 7. Layout Design of NMOS and PMOS transistors                                                                                                                                                                           |            |             |     |
| 8. Layout Design of CMOS inverter                                                                                                                                                                                       |            |             |     |

**TextBook(s):**

1. Douglas A. Pucknell and Kamran Eshraghian, *Basic VLSI Design*, 3rd ed. PHI
2. J. Bhasker, "A VHDL Primer", 3rd ed. PHI

**Reference Book(s):**

1. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic, *Digital Integrated Circuits: A Design Perspective*, 2nd ed. Pearson
2. John P. Uyemura, *Introduction to VLSI Circuits and Systems*, Wiley
3. Debaprasad Das, *VLSI Design*, Oxford University Press.

**Web and Video link(s):**

1. [https://onlinecourses.nptel.ac.in/noc24\\_ee117/preview](https://onlinecourses.nptel.ac.in/noc24_ee117/preview); NPTEL Video Lecture on VLSI DESIGN & TECHNOLOGY by Prof. Avishek Chatterjee | IIT Kharagpur

**Laboratory Manual (for laboratory component):**

1. VLSI DESIGN, TOOLS & TECHNOLOGY laboratory manual and Record Book, Department of ECE, KITSW

**Course Learning Outcomes (COs):**

After completion of this course, the students should be able to,

**CO1:** Learn VLSI fundamentals, MOS transistors, and fabrication processes.

**CO2:** Design MOS circuits and apply layout design rules

**CO3:** Develop digital circuits using VHDL

**CO4:** Use EDA tools for circuit simulation and design

*(based on psychomotor skills acquired from laboratory component)*

**CO5 :** Design and simulate basic and advanced digital circuits (logic gates, adders, flip-flops, counters) using VHDL

**CO6:** Analyze the electrical behavior and transfer characteristics of CMOS inverters through simulation

**CO7:** Design universal logic gates and CMOS circuits using transistor-level CMOS logic principles

**CO8:** Create and verify layout designs for NMOS, PMOS, and CMOS inverter structures using layout tools and design rules

| Course Articulation Matrix (CAM): |             |      | U24EC414X VLSI DESIGN, TOOLS AND TECHNOLOGY |      |      |      |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|------|---------------------------------------------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO 1 | PO 2                                        | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC414X.1 | 3    | 3                                           | 2    | 3    | 3    | 2    | --   | 2    | 2    | --    | 2     | 3     | 2     |
| CO2                               | U24EC414X.2 | 2    | 3                                           | 3    | 2    | 2    | 3    | --   | 2    | 1    | --    | 2     | 3     | 2     |
| CO3                               | U24EC414X.3 | 2    | 2                                           | 3    | 2    | 2    | 2    | --   | 2    | 1    | --    | 3     | 3     | 2     |
| CO4                               | U24EC414X.4 | 2    | 3                                           | 3    | 2    | 3    | 2    | --   | 2    | 2    | --    | 3     | 3     | 2     |
| CO5                               | U24EC414X.5 | 3    | 2                                           | 2    | 2    | 2    | 2    | --   | 2    | 1    | --    | 2     | 3     | 2     |
| CO6                               | U24EC414X.6 | 2    | 3                                           | 3    | 2    | 2    | 2    | --   | 2    | 1    | --    | 3     | 3     | 2     |
| CO7                               | U24EC414X.7 | 3    | 3                                           | 3    | 2    | 2    | 2    | --   | 2    | 1    | --    | 2     | 3     | 2     |
| CO8                               | U24EC414X.8 | 3    | 3                                           | 3    | 3    | 3    | 3    | --   | 3    | 1    | --    | 3     | 3     | 2     |
| U24EC414X                         |             | 2.5  | 2.75                                        | 2.7  | 2.25 | 2.37 | 2.25 | --   | 2.12 | 1.25 |       | 2.5   | 3     | 2     |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW     |             |      |                                             |      |      |      |      |      |      |      |       |       |       |       |

# 5<sup>th</sup> Semester Syllabus

## V SEMESTER

| S. No.                                                                                                                                                    | Category | Course Code | Course Title                                            | Lectures / week |   |    |    | Credits |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|---------------------------------------------------------|-----------------|---|----|----|---------|
|                                                                                                                                                           |          |             |                                                         | L               | T | P  | E  | C       |
| 1                                                                                                                                                         | OEC      | U24OE501    | Open Elective – I                                       | 2               | 1 | -  | 3  | 3       |
| 2                                                                                                                                                         | ESC      | U24EC502    | Linear Control Systems                                  | 2               | 1 | -  | 3  | 3       |
| 3                                                                                                                                                         | PCC      | U24EC503    | Microcontrollers and Applications                       | 2               | 1 | -  | 3  | 3       |
| 4                                                                                                                                                         | PCC      | U24EC504    | VLSI Design                                             | 2               | 1 | -  | 3  | 3       |
| 5                                                                                                                                                         | ESC      | U24EC505    | Artificial Intelligence and Machine Learning            | 2               | 1 | -  | 3  | 3       |
| 6                                                                                                                                                         | IKSC     | U24IK506A   | Essence of Indian Traditional Knowledge                 | 2               | - | -  | 2  | 2       |
| 7                                                                                                                                                         | HSMC     | U24MH507    | Technical English                                       | -               | - | 2  | 2  | 1       |
| 8                                                                                                                                                         | PCC      | U24EC508    | Microcontrollers and Applications Laboratory            | -               | - | 2  | 2  | 1       |
| 9                                                                                                                                                         | PCC      | U24EC509    | VLSI Design Laboratory                                  | -               | - | 2  | 2  | 1       |
| 10                                                                                                                                                        | ESC      | U24EC510    | Artificial Intelligence and Machine Learning Laboratory | -               | - | 2  | 2  | 1       |
| 11                                                                                                                                                        | ELC      | U24EC511    | Seminar                                                 | -               | - | 2  | 2  | 1       |
| Total:                                                                                                                                                    |          |             |                                                         | 12              | 5 | 10 | 27 | 22      |
| Additional Learning@:Maximum credits allowed forHonours/Minor                                                                                             |          |             |                                                         | -               | - | -  | -  | 5       |
| Total credits for Honours/Minor students:                                                                                                                 |          |             |                                                         | -               | - | -  | -  | 27      |
| Summer/ Inter-sem Mandatory Bridge Courses : 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet) |          |             |                                                         | -               | - | -  | -  | -       |

**#MULTIDISCIPLINARY OPEN ELECTIVES:** Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

**@List of courses for additional learning through MOOCs towards Honours/Minor in Engineering shall be prescribed by the department under Honours/Minor Curricula**

| Open Elective – I |             |                                                    |
|-------------------|-------------|----------------------------------------------------|
| S. No.            | Course Code | Course Title                                       |
| 1.                | U24OE501A   | Design Thinking                                    |
| 2.                | U24OE501B   | Innovative Product Design and Development          |
| 3.                | U24OE501C   | Entrepreneurship                                   |
| 4.                | U24OE501D   | Design Studio                                      |
| 5.                | U24OE501Z   | Any other course approved by BoS Chair and Dean AA |

| DESIGN THINKING                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                          |                       |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|
| Class: B. Tech. – V semester                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                          | Branch: Common to All |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                         | U24OE501A                                                                                                                                                                | Credits:              | 3   |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                | 2-1-0-3                                                                                                                                                                  | CIE:                  | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                      | 36 Hrs                                                                                                                                                                   | ESE:                  | 40% |
| Course Learning Outcomes (COs)                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                          |                       |     |
| After completion of this course, the students should be able to...                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                          |                       |     |
| CO1 :                                                                                                                                                                                                                                                                                                                                                                                                                | identify customer segments and needs, assess customer-problem fit using Jobs-to-be-Done (JTBD) and customer persona frameworks                                           |                       |     |
| CO2 :                                                                                                                                                                                                                                                                                                                                                                                                                | analyze market opportunities and competitive dynamics, estimate business feasibility and build prototypes/MVPs for validating innovative solutions                       |                       |     |
| CO3 :                                                                                                                                                                                                                                                                                                                                                                                                                | develop a Lean Canvas for a start-up venture by integrating value proposition, customer segments, revenue streams, key metrics and growth strategies                     |                       |     |
| CO4 :                                                                                                                                                                                                                                                                                                                                                                                                                | evaluate funding and team-building strategies and develop a scalable, investment-ready venture proposal through financial planning, validation and professional pitching |                       |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                          |                       |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                          | 9 Hrs                 |     |
| Identify and Analyze Real-world Problems: The Macro Industry View, Problem Identification & Segment Assembly, Customer Identification & Needs Validation, Assess 'Jobs-To-Be-Done' (JTBD) for a Customer Segment, Develop Customer Persona, Validate Customer-Problem fit, Pivot/Refine Customer-Problem fit for feasibility, Examine Ideation Techniques                                                            |                                                                                                                                                                          |                       |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                          | 9 Hrs                 |     |
| Solution Idea Generation & MVP: Opportunity & Competition Mapping, Prototype Development & Minimum Viable Product (MVP), Identify Global Competitors, Review Industry Trends and Estimate Market Size (TAM), Introduction to Financial Planning, Overview of Prototypes & MVP, Build an initial Prototype, Prototypes for Early Validation, Map your Relative Position in the Market, Estimate Opportunity Size      |                                                                                                                                                                          |                       |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                          | 9 Hrs                 |     |
| Market Feasibility & Business Modeling: Lean Canvas Assembly, Marketing & Go-To-Market (GTM) Strategy, Examine Revenue Models, Review and Organize Lean Canvas, Build LC for your Start-up, Build LC for your Start-up, Understand Marketing and Sales, Recommend a GTM Approach, Map a Sales Process, Building an Initial Team                                                                                      |                                                                                                                                                                          |                       |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                          | 9 Hrs                 |     |
| Financial Management, Team Scale & Final Pitch: Funding Pathways & Scaling Orientation, Validation & Venture Presentation/Collaboration, Deep Dive into Financial Planning, Analyse the Path to Profitability, Understand Bootstrapping & Funding Options, Finding Co-Founders and Mentors, Thinking Beyond the Prototype - Scale Opportunity & Orientation, Final Milestone - Venture Idea Feasibility Presentation |                                                                                                                                                                          |                       |     |
| TextBook(s):                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                          |                       |     |
| 1. Chandramouli Subramanian & Thiyagarajan p, Sankaran V, Design Thinking: A Hands-on Approach, University Press (India) Pvt. Ltd., 1st Edn., 2025, Hyderabad.                                                                                                                                                                                                                                                       |                                                                                                                                                                          |                       |     |
| Reference Book(s):                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                          |                       |     |
| 1. Andrew Pressman, Design Thinking: A Guide to Creative Problem Solving for Everyone,                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                          |                       |     |

Routledge, Taylor & Francis Group, 7th Edn., 2019, New York.

2. George E. Dieter and Linda C. Schmidt, Engineering Design, McGraw-Hill Education, 13th Edn, 2020, New Delhi.
3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperBusiness, 7th Edn., 2009, New York.
4. Karl T. Ulrich, Steven D. Eppinger, and Maria C. Yang, Product Design and Development, McGraw-Hill Education, 2020, New Delhi.
5. Tom Kelley and David Kelley, Creative Confidence: Unleashing the Creative Potential Within Us All, Crown Business, 2013, New York.
6. Idris Mootee, Design Thinking for Strategic Innovation, John Wiley & Sons, 1st Edn., 2013, New Jersey.

**Web and Video link(s):**

<https://nptel.ac.in/courses/110106124>; NPTEL Video Lecture on Design Thinking - A Primer by Prof. Ashwin Mahalingam & Prof. Bala Ramadurai, IIT Madras.

| Course Articulation Matrix (CAM): |             | U24OE501A: DESIGN THINKING |      |      |      |     |      |     |      |      |      |      |      |      |
|-----------------------------------|-------------|----------------------------|------|------|------|-----|------|-----|------|------|------|------|------|------|
| CO                                |             | PO1                        | PO2  | PO3  | PO4  | PO5 | PO6  | PO7 | PO8  | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24OE501A.1 | 2                          | 2    | 1    | 1    | 1   | 1    | -   | 1    | 1    | -    | 1    | -    | 1    |
| CO2                               | U24OE501A.2 | 1                          | 2    | 2    | 2    | 1   | 1    | 1   | 1    | 1    | -    | 1    | -    | 1    |
| CO3                               | U24OE501A.3 | 1                          | 2    | 3    | 2    | 2   | 1    | 1   | 1    | 1    | 1    | 1    | -    | 1    |
| CO4                               | U24OE501A.4 | 1                          | 1    | 3    | 2    | 2   | 2    | 1   | 2    | 2    | 2    | 2    | -    | 1    |
| U24OE501A                         |             | 1.25                       | 1.75 | 2.25 | 1.75 | 1.5 | 1.25 | 1   | 1.25 | 1.25 | 1.5  | 1.25 | -    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |                            |      |      |      |     |      |     |      |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                          |              |                                         |                                                                                         |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|-----------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                  | Relevant SDG | SDG Description                         | Mapping Justification                                                                   |
| CO1                     | identify customer segments and needs, assess customer-problem fit using Jobs-to-be-Done (JTBD) and customer persona frameworks                                           | SDG 4        | Quality Education                       | Promotes creative learning, problem-solving, and innovation skills among students.      |
|                         |                                                                                                                                                                          | SDG 9        | Industry, Innovation and Infrastructure | Encourages innovative thinking for solving engineering and societal challenges.         |
| CO2                     | analyze market opportunities and competitive dynamics, estimate business feasibility and build prototypes/MVPs for validating innovative solutions                       | SDG 3        | Good Health and Well-being              | Human-centered design improves usability, safety, and user well-being.                  |
|                         |                                                                                                                                                                          | SDG 11       | Sustainable Cities and Communities      | Supports identification of sustainable and community-oriented solutions.                |
| CO3                     | develop a Lean Canvas for a start-up venture by integrating value proposition, customer segments, revenue streams, key metrics and growth strategies                     | SDG 9        | Industry, Innovation and Infrastructure | Promotes innovation, product development, and technological advancement.                |
|                         |                                                                                                                                                                          | SDG 12       | Responsible Consumption and Production  | Encourages efficient resource utilization and sustainable product development.          |
| CO4                     | evaluate funding and team-building strategies and develop a scalable, investment-ready venture proposal through financial planning, validation and professional pitching | SDG 8        | Decent Work and Economic Growth         | Supports entrepreneurship, innovation-driven business models, and employability skills. |
|                         |                                                                                                                                                                          | SDG 9        | Industry, Innovation and Infrastructure | Encourages development of practical and scalable engineering solutions.                 |
|                         |                                                                                                                                                                          | SDG 17       | Partnerships for the Goals              | Promotes teamwork, interdisciplinary collaboration, and stakeholder interaction.        |

| INNOVATIVE PRODUCT DESIGN & DEVELOPMENT                                                                                                                                                                                                                                                                                                                                                                                    |           |                       |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------|-----|
| Class: B. Tech. – V Semester                                                                                                                                                                                                                                                                                                                                                                                               |           | Branch: Common to All |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                               | U24OE501B | Credits:              | 3   |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                      | 2-1-0-3   | CIE:                  | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                            | 36 Hrs    | ESE:                  | 40% |
| Course Learning Outcomes (COs)                                                                                                                                                                                                                                                                                                                                                                                             |           |                       |     |
| After completion of this course, the students should be able to...                                                                                                                                                                                                                                                                                                                                                         |           |                       |     |
| CO1 :create the systematic lifecycle of engineering design from customer requirements to technical specifications                                                                                                                                                                                                                                                                                                          |           |                       |     |
| CO2 :choose principles of industrial design, materials science, and ergonomics to optimize product usability                                                                                                                                                                                                                                                                                                               |           |                       |     |
| CO3 :implement the advanced rapid prototyping tools to compress the product development cycle                                                                                                                                                                                                                                                                                                                              |           |                       |     |
| CO4:design and build prototype performance using structural validation, risk analysis, and engineering metrics                                                                                                                                                                                                                                                                                                             |           |                       |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                       |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                     |           | 9 Hrs                 |     |
| Introduction to product design engineering: Translating user needs into Product Design Specifications (PDS); Quality Function Deployment (QFD) and the House of Quality framework; Functional decomposition and physical architecture mapping; Regulatory compliance, standards, and safety considerations in product architecture.                                                                                        |           |                       |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                    |           | 9 Hrs                 |     |
| Principles of Industrial Design (ID): Human-centered design and Ergonomics (Anthropometry); Visual hierarchy, form generation, and product aesthetics; Material selection frameworks (structural, thermal, electrical properties) and manufacturing process mapping (DFM/DFA: Design for Manufacturing and Assembly); Design semantics and user-interface touchpoints.                                                     |           |                       |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                   |           | 9 Hrs                 |     |
| Prototyping strategies: proof-of-concept vs. alpha/beta prototypes: Additive manufacturing (3D Printing: FDM, SLA, SLS) and subtractive techniques (CNC machining); Rapid tooling, silicone molding, and vacuum forming; Digital prototyping: Computer-Aided Design (CAD) modeling, assembly verification, and finite element simulations; Virtual and Augmented Reality (VR/AR) workflows for product spatial validation. |           |                       |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                    |           | 9 Hrs                 |     |
| Design of Experiments (DoE) for physical/digital prototypes: Robust design testing and failure analysis; Cost modeling, Bill of Materials (BOM) management, and engineering change orders (ECO); Sustainable engineering: Design for Environment (DFE) and lifecycle evaluation; Preparing the product blueprint for production scaling and supply chain onboarding.                                                       |           |                       |     |
| TextBook(s):                                                                                                                                                                                                                                                                                                                                                                                                               |           |                       |     |
| 1. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, Tata McGraw-Hill, 10th Edn, 2012, New Delhi.                                                                                                                                                                                                                                                                                                     |           |                       |     |
| Reference Book(s):                                                                                                                                                                                                                                                                                                                                                                                                         |           |                       |     |
| 1. Devdas Shetty, Product Design for Engineers, Cengage Learning, 9th Edn, 2015, Boston.                                                                                                                                                                                                                                                                                                                                   |           |                       |     |
| 2. A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, PHI Learning, 2013, 13th Edn, New Delhi.                                                                                                                                                                                                                                                                                                                 |           |                       |     |

3. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education, 2001, New Delhi.
4. Benjamin W. Niebel and Alan B. Draper, Product Design & Process Engineering, McGraw-Hill, 1974, New York.
5. Paul Trott, Innovation Management and New Product Development, Pearson Education, 2016, Harlow.

**Web and Video link(s): .**

<https://nptel.ac.in/courses/112107217>; NPTEL Video Lecture on Product Design and Development by Prof. Inderdeep Singh, Professor of Mechanical and Industrial Engineering, IIT Roorkee.

| Course Articulation Matrix (CAM): |             | U24OE501B:INNOVATIVE PRODUCT DESIGN & DEVELOPMENT |      |      |      |      |      |      |      |      |      |       |      |       |
|-----------------------------------|-------------|---------------------------------------------------|------|------|------|------|------|------|------|------|------|-------|------|-------|
| CO                                |             | PO1                                               | PO2  | PO3  | PO4  | PO 5 | PO 6 | PO 7 | PO8  | PO9  | PO10 | PO 11 | PSO1 | PSO 2 |
| CO1                               | U24OE501B.1 | 2                                                 | 2    | 1    | 1    | 1    | 1    | -    | 1    | 1    | -    | 1     | -    | 1     |
| CO2                               | U24OE501B.2 | 1                                                 | 2    | 2    | 2    | 1    | 1    | 1    | 1    | 1    | -    | 1     | -    | 1     |
| CO3                               | U24OE501B.3 | 1                                                 | 2    | 3    | 2    | 2    | 1    | 1    | 1    | 1    | 1    | 1     | -    | 1     |
| CO4                               | U24OE501B.4 | 1                                                 | 1    | 3    | 2    | 2    | 2    | 1    | 2    | 2    | 2    | 2     | -    | 1     |
| U24OE501B                         |             | 1.25                                              | 1.75 | 2.25 | 1.75 | 1.5  | 1.25 | 1    | 1.25 | 1.25 | 1.5  | 1.25  | -    | 1     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |                                                   |      |      |      |      |      |      |      |      |      |       |      |       |

**Course Outcome and SDG Goal Mapping:**

| CO-SDG Alignment Matrix |                                                                                                              |              |                                         |                                                                                         |
|-------------------------|--------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|-----------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                      | Relevant SDG | SDG Description                         | Mapping Justification                                                                   |
| CO1                     | create the systematic lifecycle of engineering design from customer requirements to technical specifications | SDG 4        | Quality Education                       | Promotes creative learning, problem-solving, and innovation skills among students.      |
|                         |                                                                                                              | SDG 9        | Industry, Innovation and Infrastructure | Encourages innovative thinking for solving engineering and societal challenges.         |
| CO2                     | choose principles of industrial design, materials science, and ergonomics to optimize product usability      | SDG 3        | Good Health and Well-being              | Human-centered design improves usability, safety, and user well-being.                  |
|                         |                                                                                                              | SDG 11       | Sustainable Cities and Communities      | Supports identification of sustainable and community-oriented solutions.                |
| CO3                     | implement the advanced rapid prototyping tools to compress the product development cycle                     | SDG 9        | Industry, Innovation and Infrastructure | Promotes innovation, product development, and technological advancement.                |
|                         |                                                                                                              | SDG 12       | Responsible Consumption and Production  | Encourages efficient resource utilization and sustainable product development.          |
| CO4                     | design and build prototype performance using structural validation, risk analysis, and engineering metrics   | SDG 8        | Decent Work and Economic Growth         | Supports entrepreneurship, innovation-driven business models, and employability skills. |
|                         |                                                                                                              | SDG 9        | Industry, Innovation and Infrastructure | Encourages development of practical and scalable engineering solutions.                 |
|                         |                                                                                                              | SDG 17       | Partnerships for the                    | Promotes teamwork, interdisciplinary                                                    |

| CO-SDG Alignment Matrix |                                                         |                 |                 |                                             |
|-------------------------|---------------------------------------------------------|-----------------|-----------------|---------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i> | Relevant<br>SDG | SDG Description | Mapping Justification                       |
|                         |                                                         |                 | Goals           | collaboration, and stakeholder interaction. |

| ENTREPRENEURSHIP                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                       |                       |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----|
| Class: B. Tech. – V Semester                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                       | Branch: Common to All |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                     | U24OE501C                                                                                                                                             | Credits:              | 3   |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                            | 2-1-0-3                                                                                                                                               | CIE:                  | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                  | 36 Hrs                                                                                                                                                | ESE:                  | 40% |
| Course Learning Outcomes (COs)                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                       |                       |     |
| After completion of this course, the students should be able to...                                                                                                                                                                                                                                                                                                               |                                                                                                                                                       |                       |     |
| CO1 :                                                                                                                                                                                                                                                                                                                                                                            | develop an entrepreneurial mindset and create scalable business concepts through the analysis of opportunities and evaluation of business feasibility |                       |     |
| CO2 :                                                                                                                                                                                                                                                                                                                                                                            | analyze and validate customer needs, market demands, and pain points using structured customer discovery techniques                                   |                       |     |
| CO3 :                                                                                                                                                                                                                                                                                                                                                                            | create students with practical knowledge of business modeling, unit economics, and venture monetization                                               |                       |     |
| CO4 :                                                                                                                                                                                                                                                                                                                                                                            | build a clear roadmap for executing, legally safeguarding, and pitching a new venture                                                                 |                       |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                       | 9 Hrs                 |     |
| <b>Introduction to Entrepreneurship:</b> definitions, characteristics, and the evolution of an entrepreneurial ecosystem; Myths vs. Realities of starting up; Types of entrepreneurship (Social, Tech, Lifestyle, and Corporate);                                                                                                                                                |                                                                                                                                                       |                       |     |
| <b>Developing an entrepreneurial mindset:</b> risk-taking, resilience, self-efficacy, and dealing with failure; Identifying personal strengths and alignment with venture archetypes.                                                                                                                                                                                            |                                                                                                                                                       |                       |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                       | 9 Hrs                 |     |
| <b>Deep-dive Problem Identification:</b> moving from generic ideas to systemic problems; Root-cause analysis, stakeholder mapping, and ecosystem friction points;                                                                                                                                                                                                                |                                                                                                                                                       |                       |     |
| <b>Customer Discovery methodology:</b> conducting ethnographic interviews, building user personas, and mapping customer archetypes; Validating market pain points vs. "nice-to-have" solutions; Value Proposition Canvas framework.                                                                                                                                              |                                                                                                                                                       |                       |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                       | 9 Hrs                 |     |
| <b>Designing the business architecture:</b> Introduction to the Lean Canvas and Business Model Canvas (BMC); Revenue streams, pricing strategies, and cost structures;                                                                                                                                                                                                           |                                                                                                                                                       |                       |     |
| <b>Fundamentals of Unit Economics:</b> Customer Acquisition Cost (CAC), Lifetime Value (LTV), and break-even analysis; Competitor analysis and establishing a Sustainable Competitive Advantage (Moat); Basics of bootstrapping vs. external funding.                                                                                                                            |                                                                                                                                                       |                       |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                       | 9 Hrs                 |     |
| <b>Building the Go-To-Market (GTM) strategy:</b> marketing channels, sales funnels, and early user acquisition; Basics of business registration, legal structures (LLP, Pvt Ltd), and intellectual property (IP) awareness; Building an early founding team, equity splitting models, and culture; Final capstone venture pitch preparation: structuring an investor pitch deck. |                                                                                                                                                       |                       |     |

**TextBook(s):**

1. Robert D. Hisrich, Michael P. Peters, and Dean A. Shepherd, Entrepreneurship, McGraw-Hill Education, 1st Edn, 2020, New Delhi.

**Reference Book(s):**

1. Poornima M. Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education, 5th Edn, 2018, New Delhi.
2. Bruce R. Barringer and R. Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, Pearson, 4th Edn, 2019, New Delhi.
3. Eric Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation, Crown Business, 2011, New York.
4. S. S. Khanka, Entrepreneurship Development, S. Chand & Company, 2010, New Delhi.
5. Peter Thiel, Zero to One: Notes on Startups, or How to Build the Future, Crown Business, 2014, New York.

**Web and Video link(s):**

<https://nptel.ac.in/courses/110105067>; NPTEL Video Lecture on Entrepreneurship Essentials by Prof. Rajeev Roy, Entrepreneurship Development Cell, IIT Kharagpur.

| Course Articulation Matrix (CAM): |             | U24OE501C: ENTREPRENEURSHIP |      |      |      |     |      |      |      |      |       |       |       |       |
|-----------------------------------|-------------|-----------------------------|------|------|------|-----|------|------|------|------|-------|-------|-------|-------|
| CO                                |             | PO1                         | PO2  | PO3  | PO4  | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 |
| CO1                               | U24OE501C.1 | 2                           | 2    | 1    | 1    | 1   | 1    | -    | 1    | 1    | -     | 1     | -     | -     |
| CO2                               | U24OE501C.2 | 1                           | 2    | 2    | 2    | 1   | 1    | 1    | 1    | 1    | -     | 1     | -     | -     |
| CO3                               | U24OE501C.3 | 1                           | 2    | 3    | 2    | 2   | 1    | 1    | 1    | 1    | 1     | 1     | -     | -     |
| CO4                               | U24OE501C.4 | 1                           | 1    | 3    | 2    | 2   | 2    | 1    | 2    | 2    | 2     | 2     | -     | -     |
| U24OE501C                         |             | 1.25                        | 1.75 | 2.25 | 1.75 | 1.5 | 1.25 | 1    | 1.25 | 1.25 | 1.5   | 1.25  | -     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |                             |      |      |      |     |      |      |      |      |       |       |       |       |

**CO-SDG Alignment Matrix**

| CO  | CO Statement<br><i>The student should be able to...</i>                                                                                               | Relevant<br>SDG | SDG Description                         | Mapping Justification                                                                                                                                |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | develop an entrepreneurial mindset and create scalable business concepts through the analysis of opportunities and evaluation of business feasibility | SDG 4           | Quality Education                       | Enhances entrepreneurial learning by fostering creativity, critical thinking, and practical problem-solving skills.                                  |
|     |                                                                                                                                                       | SDG 9           | Industry, Innovation and Infrastructure | Promotes innovation and entrepreneurship by encouraging the development of scalable ventures that contribute to industrial and technological growth. |
| CO2 | analyze and validate customer needs, market demands, and pain                                                                                         | SDG 3           | Good Health and Well-being              | Facilitates the identification and validation of healthcare-related needs, leading to more user-centric and                                          |

| CO-SDG Alignment Matrix |                                                                                                         |                 |                                         |                                                                                                                                                           |
|-------------------------|---------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                 | Relevant<br>SDG | SDG Description                         | Mapping Justification                                                                                                                                     |
|                         | points using structured customer discovery techniques                                                   |                 |                                         | impactful well-being solutions.                                                                                                                           |
|                         |                                                                                                         | SDG 11          | Sustainable Cities and Communities      | Supports the development of community-focused innovations by understanding urban challenges and designing solutions aligned with citizens' needs          |
| CO3                     | create students with practical knowledge of business modeling, unit economics, and venture monetization | SDG 9           | Industry, Innovation and Infrastructure | Strengthens innovation ecosystems by enabling the commercialization and scaling of technology-driven ventures.                                            |
|                         |                                                                                                         | SDG 12          | Responsible Consumption and Production  | Encourages sustainable business practices by integrating resource efficiency, value creation, and responsible production principles into venture planning |
| CO4                     | build a clear roadmap for executing, legally safeguarding, and pitching a new venture                   | SDG 8           | Decent Work and Economic Growth         | Promotes entrepreneurship and job creation by enabling the successful launch and growth of innovative ventures.                                           |
|                         |                                                                                                         | SDG 9           | Industry, Innovation and Infrastructure | Supports innovation-driven enterprises by facilitating the protection, development, and scaling of new technologies and business models                   |
|                         |                                                                                                         | SDG 17          | Partnerships for the Goals              | Encourages collaboration with investors, industry partners, mentors, and institutions to strengthen venture growth and impact.                            |

| DESIGN STUDIO                                                                                                                                                                                                                                                                                                                                   |                                                                                                                      |                       |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------|-----|
| Class: B. Tech. – V Semester                                                                                                                                                                                                                                                                                                                    |                                                                                                                      | Branch: Common to All |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                    | U24OE501D                                                                                                            | Credits:              | 3   |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                           | 2-1-0-3                                                                                                              | CIE:                  | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                 | 36 Hrs                                                                                                               | ESE:                  | 40% |
| CO1 :                                                                                                                                                                                                                                                                                                                                           | deconstruct ambiguous real-world problems into rigorous R&D challenges using patent search and prior-art techniques. |                       |     |
| CO2 :                                                                                                                                                                                                                                                                                                                                           | apply system-level architecture and feasibility models to design technical solutions.                                |                       |     |
| CO3 :                                                                                                                                                                                                                                                                                                                                           | build and synthesize functional high-fidelity prototypes / MVPs leveraging modern engineering tools.                 |                       |     |
| CO4 :                                                                                                                                                                                                                                                                                                                                           | validate engineering assumptions via stakeholder co-creation and design an institutional go-to-market plan.          |                       |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                          |                                                                                                                      | 9 Hrs                 |     |
| Foundations of R&D-led entrepreneurship; Identifying deep-tech and high-impact industry problems; Advanced root-cause analysis; Literature review, patent landscaping, and prior art search; Defining the innovation thesis and scientific/technological core; Drafting the initial Product Design Brief.                                       |                                                                                                                      |                       |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                         |                                                                                                                      | 9 Hrs                 |     |
| Translating insights into technical concepts; Systematic brainstorming and TRIZ (Theory of Inventive Problem Solving) basics; Technology readiness level (TRL) mapping; Engineering/architectural design and system topology; Value proposition design and business-technical feasibility modeling; The "Napkin Pitch" for technical solutions. |                                                                                                                      |                       |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                        |                                                                                                                      | 9 Hrs                 |     |
| Rapid prototyping paradigms (Software/Hardware/Service); Formulating the Minimum Viable Product (MVP) core feature matrix; Materials selection and Agile development sprints; UI/UX wireframing or hardware schematics; Functional architecture implementation; Risk assessment and failure mode effects analysis (FMEA).                       |                                                                                                                      |                       |     |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                         |                                                                                                                      | 9 Hrs                 |     |
| Surface key engineering and market assumptions; Empirical testing protocols, simulation, and data collection; Customer co-creation loops and iterative engineering; Feedback analysis from key industry stakeholders; Creating the product "On-Ramp" strategy (Go-To-Market roadmap, Pilot launch framework, and IP Protection).                |                                                                                                                      |                       |     |
| TextBook(s):                                                                                                                                                                                                                                                                                                                                    |                                                                                                                      |                       |     |
| 1. Brian Sullivan, The Design Studio Method: Creative Problem Solving with UX Sketching, Routledge, 2015, New York.                                                                                                                                                                                                                             |                                                                                                                      |                       |     |
| Reference Book(s):                                                                                                                                                                                                                                                                                                                              |                                                                                                                      |                       |     |
| 1. Elizabeth Boling, James Benedict Brown, Colin M. Gray, and Derek Jones, Studio Properties: A Field Guide to Design Education, Yale Press, 2021, New Haven.                                                                                                                                                                                   |                                                                                                                      |                       |     |
| 2. Charles Eastman, W. Michael McCracken, and Wendy Newstetter, Design Knowing and Learning: Cognition in Design Education, Elsevier, 2001, Oxford.                                                                                                                                                                                             |                                                                                                                      |                       |     |
| 3. Donald A. Schön, Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions, Jossey-Bass, 17th Edn, 1987, San Francisco.                                                                                                                                                                        |                                                                                                                      |                       |     |
| 4. Jerzy Wojtowicz, Virtual Design Studio, Hong Kong University Press, 8th Edn, 1995, Hong                                                                                                                                                                                                                                                      |                                                                                                                      |                       |     |

Kong.

- Lois Hetland and Ellen Winner, Studio Thinking: The Real Benefits of Visual Arts Education, Teachers College Press, 12th Edn, 2007, New York.

**Web and Video link(s):**

<https://nptel.ac.in/courses/124105003>; NPTEL Video Lecture on Understanding Design by Prof. Prasad Onkar, Department of Design, IIT Hyderabad.

| Course Articulation Matrix (CAM): |             | U24OE501D: DESIGN STUDIO |          |          |          |      |          |      |          |          |       |       |       |       |
|-----------------------------------|-------------|--------------------------|----------|----------|----------|------|----------|------|----------|----------|-------|-------|-------|-------|
| CO                                |             | PO 1                     | PO 2     | PO 3     | PO 4     | PO 5 | PO 6     | PO 7 | PO 8     | PO 9     | PO1 0 | PO1 1 | PSO 1 | PSO 2 |
| CO1                               | U24OE501D.1 | 2                        | 2        | 1        | 1        | 1    | 1        | -    | 1        | 1        | -     | 1     | -     | -     |
| CO2                               | U24OE501D.2 | 1                        | 2        | 2        | 2        | 1    | 1        | 1    | 1        | 1        | -     | 1     | -     | -     |
| CO3                               | U24OE501D.3 | 1                        | 2        | 3        | 2        | 2    | 1        | 1    | 1        | 1        | 1     | 1     | -     | -     |
| CO4                               | U24OE501D.4 | 1                        | 1        | 3        | 2        | 2    | 2        | 1    | 2        | 2        | 2     | 2     | -     | -     |
| U24OE501D                         |             | 1.2<br>5                 | 1.7<br>5 | 2.2<br>5 | 1.7<br>5 | 1.5  | 1.2<br>5 | 1    | 1.2<br>5 | 1.2<br>5 | 1.5   | 1.25  | -     | -     |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |                          |          |          |          |      |          |      |          |          |       |       |       |       |

| CO-SDG Alignment Matrix |                                                                                                                      |             |                                         |                                                                                                                                                                                   |
|-------------------------|----------------------------------------------------------------------------------------------------------------------|-------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | Course Outcome                                                                                                       | Mapped SDGs |                                         | Justification                                                                                                                                                                     |
| CO1                     | deconstruct ambiguous real-world problems into rigorous R&D challenges using patent search and prior-art techniques. | SDG 4       | Quality Education                       | Promotes experiential and innovation-based learning by equipping learners with problem-solving, research, and intellectual property skills essential for the 21st century         |
|                         |                                                                                                                      | SDG 9       | Industry, Innovation and Infrastructure | Fosters innovation capacity by encouraging the development of novel technologies, strengthening industry-oriented research, and supporting sustainable technological advancement. |
| CO2                     | apply system-level architecture and feasibility models to design technical solutions.                                | SDG 3       | Good Health and Well-being              | Supports the design of reliable healthcare technologies and systems that enhance accessibility, efficiency, and overall well-being                                                |
|                         |                                                                                                                      | SDG 11      | Sustainable Cities and Communities      | Facilitates the creation of smart, resilient, and resource-efficient infrastructure solutions that improve urban sustainability and quality of life.                              |
| CO3                     | build and synthesize functional high-fidelity prototypes / MVPs leveraging modern engineering tools.                 | SDG 9       | Industry, Innovation and Infrastructure | Promotes technological innovation and strengthens engineering capabilities by accelerating product development and industry-relevant solutions.                                   |
|                         |                                                                                                                      | SDG 12      | Responsible Consumption and Production  | Encourages efficient resource utilization, iterative design, and sustainable product development practices that minimize waste and optimize production processes.                 |
| CO4                     | validate engineering                                                                                                 | SDG 8       | Decent Work                             | Supports entrepreneurship, innovation-                                                                                                                                            |

| CO-SDG Alignment Matrix |                                                                                                     |                |                                               |                                                                                                                                                 |
|-------------------------|-----------------------------------------------------------------------------------------------------|----------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | Course Outcome                                                                                      | Mapped<br>SDGs |                                               | Justification                                                                                                                                   |
|                         | assumptions via<br>stakeholder co-creation<br>and design an<br>institutional go-to-<br>market plan. |                | and Economic<br>Growth                        | driven employment, and sustainable<br>economic growth through market-<br>oriented solution development.                                         |
|                         |                                                                                                     | SDG 9          | Industry,<br>Innovation and<br>Infrastructure | Strengthens industry-academia<br>innovation ecosystems by facilitating the<br>translation of validated technologies into<br>scalable solutions. |
|                         |                                                                                                     | SDG 17         | Partnerships for<br>the Goals                 | Encourages collaboration among<br>academia, industry, government, and<br>end users to co-create impactful and<br>sustainable innovations.       |

| <b>LINEAR CONTROL SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                    |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|--------------|
| <b>Class:</b> B.Tech. V -Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>U24EC502</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>2-1-0-3</b>  | <b>CIE Marks :</b> | <b>60 %</b>  |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>36Hrs</b>    | <b>ESE Marks :</b> | <b>40 %</b>  |
| <b>Course Learning Outcomes (COs):</b><br><i>After completion of this course, the students should be able to,</i><br><b>CO1:</b> determine transfer function of dynamical systems using block diagram and signal flow graph methods<br><b>CO2:</b> determine the time-domain specifications of first & second-order systems and compare the performance of P, PI, PD and PID controllers<br><b>CO3:</b> assess system stability in both time and frequency domains<br><b>CO4:</b> formulate the state-space model of a given physical system and explore the fundamental concepts of compensators                                         |                 |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                    | <b>9 Hrs</b> |
| <b>Concepts of Control systems:</b> Introduction, Classification of control systems, Open loop and closed loop control systems, Effects of feedback, Mathematical modelling – Linear differential equations- Translational and rotational mechanical systems, Analogous systems, Electro-mechanical systems, Electrical systems, Block diagram reduction technique, Signal flow graph method, Mason's Gain formula                                                                                                                                                                                                                        |                 |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                    | <b>9 Hrs</b> |
| <b>Control System Components:</b> AC & DC Servomotors, Synchro's<br><b>Time Response Analysis:</b> Introduction, Standard test signals – Type and order, Time response of first order systems, Classification of second order systems, Transient response of second order systems – Time domain specifications – Steady state response – Steady state errors and error constants, Controllers - P, I,D, PI, PD& PID                                                                                                                                                                                                                       |                 |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                    | <b>9 Hrs</b> |
| <b>Stability Analysis:</b> Introduction, Routh-Hurwitz stability criteria – Qualitative stability and conditional stability, Root locus technique– Construction of root loci-Effects of adding poles and zeros to $G(s)H(s)$ on the root loci<br><b>Frequency Response Analysis:</b> Introduction, Frequency domain specifications -Correlation between frequency and time domain specifications- Bode plots- Transfer function from the bode plot- Phase margin and gain margin-Stability analysis from bode plots, Stability analysis through polar plots, Nyquist stability criteria, Determining the response of systems using MATLAB |                 |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                    | <b>9 Hrs</b> |
| <b>Control System Analysis using State Variable Method:</b> Introduction- State variable representation conversion of state models to transfer functions- Conversion of transfer functions to state models deriving state models from physical systems, State transition matrix, Solution of state equations concepts of controllability and observability<br><br><b>Compensation:</b> Introduction, Elementary treatment of lead, Lag and lead-lag compensation                                                                                                                                                                          |                 |                    |              |
| <b>TextBook(s):</b><br>1. A. Anand Kumar, <i>Control Systems</i> , 2 <sup>nd</sup> ed., New Delhi: Prentice Hall of India, 2014                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                    |              |
| <b>Reference Book(s):</b><br>1. I.J.Nagrath& M. Gopal, <i>Control Systems Engineering</i> , 4 <sup>th</sup> ed., New Delhi: New Age International                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                    |              |

2. S. Palani, *Control Systems Engineering*, 2<sup>nd</sup> ed., New Delhi: Tata McGraw Hill Education (India) Pvt. Ltd., 2010
3. K. Ogata, *Modern Control Engineering*, 5<sup>th</sup> ed., New Delhi: Prentice Hall of India, 2010.
4. Benjamin C. Kuo, *Automatic Control Systems*, 7<sup>th</sup> ed., New Delhi: Prentice Hall of India, 1995

**Web and Video link(s):**

<https://nptel.ac.in/courses/108106098//>; NPTEL Video Lecture on Control Engineering by Prof. Ramkrishna Pasumarthi, Professor of EED, IIT Madras.

| Course Articulation Matrix (CAM): |            |      |      |      | U24EC502: LINEAR CONTROL SYSTEMS |      |      |      |      |      |       |       |       |       |
|-----------------------------------|------------|------|------|------|----------------------------------|------|------|------|------|------|-------|-------|-------|-------|
| CO                                |            | PO 1 | PO 2 | PO 3 | PO 4                             | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 |
| CO1                               | U24EC502.1 | 2    | 2    | -    | -                                | -    | -    | -    | -    | -    | -     | 1     | 1     | -     |
| CO2                               | U24EC502.2 | 2    | 2    | -    | 1                                | -    | -    | -    | -    | -    | -     | 1     | 1     | 1     |
| CO3                               | U24EC502.3 | 2    | 2    | -    | 1                                | 1    | -    | -    | 1    | -    | -     | 1     | 1     | 1     |
| CO4                               | U24EC502.4 | 2    | 2    | -    | 1                                | -    | -    | -    | 1    | -    | -     | 1     | 1     | 1     |
| U24EC502                          |            | 2    | 2    | -    | 1                                | 1    | -    | -    | 1    | -    | -     | 1     | 1     | 1     |

| CO-SDG Alignment Matrix |                                                                                                                                       |                 |                                         |                                                                                                                                                                                         |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                               | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                   |
| CO1                     | determine transfer function of dynamical systems using block diagram and signal flow graph methods                                    | SDG9            | Industry, Innovation and Infrastructure | Mathematical modeling of dynamical systems forms the basis for the design and analysis of modern industrial automation and intelligent engineering systems.                             |
| CO2                     | determine the time-domain specifications of first & second-order systems and compare the performance of P, PI, PD and PID controllers | SDG7            | Affordable and Clean Energy             | Control techniques improve the efficiency, stability, and energy management of renewable energy systems, electrical drives, and power systems, supporting sustainable energy solutions. |
| CO3                     | assess system stability in both time and frequency domains                                                                            | SDG9            | Industry, Innovation and Infrastructure | Stability analysis is essential for ensuring the reliable and safe operation of industrial automation, robotics, aerospace, and manufacturing systems.                                  |
| CO4                     | formulate the state-space model of a given physical system and explore the fundamental concepts of compensators                       | SDG9            | Industry, Innovation and Infrastructure | State-space modeling and compensator design enable the development of robust and efficient control systems for advanced industrial processes and smart infrastructure.                  |

## MICROCONTROLLERS AND APPLICATIONS

|                                        |                 |                    |            |
|----------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. V – Semester    |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC503</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P- E):</b>          | <b>2-1-0-3</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1:** explain the evolution and architectures of Microprocessors & Microcontrollers
- CO2:** configure a given microcontroller-based system for timer-counter /serial communication /interrupt operation
- CO3:** interface appropriate peripheral devices, memory with microcontroller for given application
- CO4:** able to design and build functional prototype for real world applications

|               |              |
|---------------|--------------|
| <b>UNIT-I</b> | <b>9 Hrs</b> |
|---------------|--------------|

**8051 Architecture:** 8051 Microcontroller Hardware, Pin configuration of 8051 Microcontroller, Addressing Modes, Instruction Set, External Memory

**Overview of Special Function Registers (SFRs):** TCON, TMOD, SCON, SBUF, PCON, IE, Counters and Timers - Modes of Operation, Interrupts,

**Assembly language programming:** to perform arithmetic operations, sorting of numbers

|                |              |
|----------------|--------------|
| <b>UNIT-II</b> | <b>9 Hrs</b> |
|----------------|--------------|

**ARM Embedded Systems:** Embedded system hardware, embedded system software, the Acorn RISC Machine, RISC Design philosophy, ARM Design Philosophy, ARM processor families, Core extensions, Architecture revisions.

**The ARM Architecture and Programmers Model:** ARM Core data flow model, Architectural inheritance, The ARM7TDMI programmer's model: registers, CPSR, SPSR, The memory system, Pipeline, Exceptions, Interrupts and the vector table, load and store architecture, ARM development tools.

|                 |              |
|-----------------|--------------|
| <b>UNIT-III</b> | <b>9 Hrs</b> |
|-----------------|--------------|

**ARM Instruction set:** Data processing instructions, Branch instructions, Load and store instructions, Software interrupt instructions, Program status register instructions, loading constants, Conditional execution

**Thumb instruction set:** Thumb Register usage, Thumb Register Usage, ARM-Thumb Interworking and other Branch Instructions. Data Processing Instructions, Single-Register Load-Store Instructions, Multiple-Register Load Store Instructions, Stack Instructions, Software Interrupt Instructions;

**Assembly language programs** for shifting of data, factorial calculation, swapping register contents.

| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 9 Hrs |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <p><b>ARM7 Based Microcontroller LPC2148:</b> Features, Applications, Block Diagram, memory mapping, Functional features of Interrupt controller, RTC, USB, UART, I2C, SPI, controllers, watchdog timers and other system control units; Peripherals: Pin Connect Block- Features, Register description with example. GPIO-Features, Applications, Pin description, Register description with examples PLL-Features, block diagram, bit structure of PLLCON, PLLCFG, &amp; PLLSTAT, and PLLFEED. PLL frequency Calculation- procedure for determining PLL settings, examples for PLL Configuration Timers-Features, applications, Architecture of timer module, register description.</p> <p><b>Programming of LPC2148:</b> C programs for General purpose I/O, interfacing with LED, general purpose timer, PWM modulator, UART</p> |       |
| <p><b>Textbook(s):</b></p> <ol style="list-style-type: none"> <li>1. K. J. Ayala, D. V. <i>The 8051 Microcontroller &amp; Embedded Systems using Assembly and C</i>, Gadre, Cengage Learning (Chapters 1 to 7, 9 to 12)</li> <li>2. Sloss, Andrew, Dominic Symes, and Chris Wright. <i>ARM system developer's guide: designing and optimizing system software</i>. Elsevier, 2004</li> <li>3. LPC2148 User manual</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                         |       |
| <p><b>Reference Book(s):</b></p> <ol style="list-style-type: none"> <li>1. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay <i>the 8051 Microcontroller and Embedded Systems Using Assembly and C</i>, 2nd Edition, Pearson Education</li> <li>2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", TMH Publications, Second Edition, 2008.</li> <li>3. Furber, Stephen Bo. <i>ARM system-on-chip architecture</i>, New Delhi: Pearson Education, 2000</li> <li>4. Predko M., <i>Programming and Customizing the 8051 Microcontroller</i>, McGraw-Hill, 1999</li> </ol>                                                                                                                                                                                                                             |       |
| <p><b>Web and Video link(s):</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/108105102">https://nptel.ac.in/courses/108105102</a>; NPTEL Video Lecture on Microprocessors and Microcontrollers by Prof. Santanu Chattopadhyay, Professor of EEE, IIT Kharagpur.</li> <li>2. <a href="http://www.digimat.in/nptel/courses/video/117106111/L03.html">http://www.digimat.in/nptel/courses/video/117106111/L03.html</a></li> <li>3. <a href="https://www.youtube.com/playlist?list=PLbMVogVj5nJRDS4w20GO714SepLhuAj9X">https://www.youtube.com/playlist?list=PLbMVogVj5nJRDS4w20GO714SepLhuAj9X</a></li> <li>4. <a href="https://youtu.be/s00xmJA5CXY?si=bpzHDSpMZE-9LPjS">https://youtu.be/s00xmJA5CXY?si=bpzHDSpMZE-9LPjS</a></li> </ol>                                                        |       |

| Course Articulation Matrix (CAM): |            |      |     | U24EC503: MICROCONTROLLERS AND APPLICATIONS |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|------|-----|---------------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1  | PO2 | PO3                                         | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC503.1 | 1    | 2   | 2                                           | 1    | -   | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC503.2 | 2    | 2   | 2                                           | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO3                               | U24EC503.3 | 2    | 2   | 2                                           | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC503.4 | 2    | 2   | 3                                           | 3    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| U24EC503                          |            | 1.75 | 2   | 2.25                                        | 1.75 | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |     |                                             |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                             |                 |                                         |                                                                                                                                                                                                                 |
|-------------------------|-------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                     | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                                           |
| CO1                     | explain the evolution and architectures of Microprocessors & Microcontrollers                               | SDG3            | Good Health and Well-being              | Modern architectures emphasize low power, high-speed computation, and integrated artificial intelligence (TinyML) to support real-time monitoring and improved diagnostics                                      |
| CO2                     | configure a given microcontroller-based system for timer-counter /serial communication /interrupt operation | SDG9            | Industry, Innovation and Infrastructure | microcontrollerbased system for timer-counter or serialcommunication or interrupt operation are used in industrial and satellite imaging systems, supporting reliable infrastructure monitoring and innovation. |
| CO3                     | interface appropriate peripheral devices, memory with microcontroller for given application                 | SDG11           | Sustainable Cities and Communities      | memory with microcontroller enable applications like traffic analysis, surveillance, and urban monitoring, contributing to safer and smarter cities.                                                            |
| CO4                     | ability to design and build functional prototype for real world applications                                | SDG9            | Industry, Innovation and Infrastructure | Feature extraction and classification form the backbone of AI-driven systems such as autonomous vehicles, industrial automation, and smart analytics, fostering technological innovation.                       |

| VLSI DESIGN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |             |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|-------|
| Class: B. Tech. V – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | U24EC504 | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2-1-0-3  | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 36Hrs    | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |             |       |
| <b>CO1 :</b> Explain MOS fabrication processes and Analyze the electrical characteristics of MOS transistors and CMOS inverter circuits.<br><b>CO2 :</b> Apply VLSI layout design concepts including stick diagrams, design rules, scaling and basic circuit parameters in CMOS circuits.<br><b>CO3 :</b> Design and Analyze CMOS digital subsystems using arithmetic building blocks, switch logic and dynamic CMOS logic techniques.<br><b>CO4 :</b> Analyze and design analog CMOS building blocks such as amplifiers, current mirrors, and differential pairs using small signal models. |          |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |             | 9 Hrs |
| <b>Introduction to MOS Technology:</b> Introduction to IC technology, Evolution of VLSI, Basic MOS transistor, Process steps in fabricating MOSFET, Fabrication process of nMOS, CMOS and BiCMOS transistors.<br><br><b>Basic Electrical Properties of MOS Transistor:</b> Drain to source current and voltage relation, Threshold voltage, Transconductance, nMOS inverter, Pull up/Pull down ratios, Alternate forms of pull up, CMOS inverter, BiCMOS inverter, Latch-up in CMOS circuits                                                                                                 |          |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |             | 9 Hrs |
| <b>MOS Circuit Design Processes:</b> VLSI design flow, MOS layers, Stick diagrams - nMOS design style and CMOS design style, Lambda based design rules and Layout diagrams, Scaling of MOS circuits.<br><br><b>Basic Circuit Concepts:</b> Sheet resistance, Area capacitances of layers, Delay unit, Inverter delays, Rise time and Fall time estimation                                                                                                                                                                                                                                    |          |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |             | 9 Hrs |
| <b>Data path Subsystems:</b> Introduction, architectures for adders, multipliers, and shifters, speed and area trade-offs, One/ Zero detector, comparators.<br><br><b>Switch and Dynamic CMOS logic:</b> Pass transistor and CMOS transmission gates, Pseudo nMOS logic, Dynamic CMOS logic, Domino CMOS Logic.                                                                                                                                                                                                                                                                              |          |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |             | 9 Hrs |
| <b>Analog IC Building Blocks:</b> Analysis of MOSFET small signal model, Qualitative Analysis of Common source amplifier with different loads, Source follower, common gate stage, cascode stage, Current sources and sinks, Basic current mirror, cascode current mirror, Qualitative Analysis of Basic differential amplifier.                                                                                                                                                                                                                                                             |          |             |       |

**TextBook(s):**

1. Douglas A Pucknell and Kamran Eshraghian, Basic VLSI Design, 3rd ed., New Delhi: PHI, 2008. (Chapters 1 to 6)
2. Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2nd Edition, Tata McGraw-Hill, 2017

**Reference Book(s):**

1. Neil H. E. Weste, David Harris and Ayan Banerjee, CMOS VLSI Design - A Circuits and Systems Perspective, 3rd ed., New Delhi: Pearson Education, 2005. (Chapter 11)
2. CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, 3rd Edition, Tata McGraw-Hill, 2011
3. Digital Integrated Circuits - A Design Perspective, Jan M. Rabaey, AnanthaChandrakasan, Borivoje Nikolic, 2nd Edition, PHI, 2016.

**Web and Video link**

[https://onlinecourses.nptel.ac.in/e-learning/preview/noc26\\_ee85](https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee85); NPTEL Video Lecture on CMOS Digital VLSI Design by Prof. Sudeb Dasgupta, Professor of Electrical Engineering, IIT Roorkee.

| Course Articulation Matrix (CAM): |            | U24EC504 : VLSI DESIGN |     |     |      |     |     |      |     |     |      |      |      |      |
|-----------------------------------|------------|------------------------|-----|-----|------|-----|-----|------|-----|-----|------|------|------|------|
| CO                                |            | PO1                    | PO2 | PO3 | PO4  | PO5 | PO6 | PO7  | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC504.1 | 2                      | 2   | 3   | 1    | -   | -   | 1    | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC504.2 | 2                      | 2   | 3   | 2    | 1   | -   | 1    | -   | 1   | -    | 2    | 2    | 2    |
| CO3                               | U24EC504.3 | 2                      | 2   | 3   | 2    | 1   | -   | -    | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC504.4 | 2                      | 2   | 3   | 2    | -   | -   | 1    | -   | 1   | -    | 2    | 2    | 2    |
| U24EC504                          |            | 2                      | 2   | 3   | 1.75 | 0.5 | -   | 0.75 | -   | 1   | -    | 1.5  | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |                        |     |     |      |     |     |      |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                       |                 |                                         |                                                                                                                                                            |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                               | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                      |
| CO1                     | Explain MOS fabrication processes and analyze the electrical characteristics of MOS transistors and CMOS inverter circuits.           | SDG9            | Industry, Innovation and Infrastructure | MOS fabrication and CMOS technology form the foundation of modern semiconductor industries and innovative electronic infrastructure.                       |
| CO2                     | Apply VLSI layout design concepts including stick diagrams, design rules, scaling and basic circuit parameters in CMOS circuits.      | SDG7            | Affordable and Clean Energy             | CMOS scaling and optimized VLSI layouts help in developing compact and low-power electronic circuits that support energy-efficient system design.          |
| CO3                     | Design and Analyze CMOS digital subsystems using arithmetic building blocks, switch logic and dynamic CMOS logic techniques.          | SDG9            | Industry, Innovation and Infrastructure | CMOS digital subsystem design enables development of high-performance processors and smart electronic systems used in modern technological infrastructure. |
| CO4                     | Analyze and design analog CMOS building blocks such as amplifiers, current mirrors, and differential pairs using small signal models. | SDG3            | Good Health and Well-being              | Analog CMOS circuits are widely used in biomedical instruments, communication systems, and healthcare electronic devices for reliable signal processing.   |

# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                    |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|--------------|
| <b>Class:</b> B. Tech. V – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>U24EC505</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>2-1-0-3</b>  | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>36 Hrs</b>   | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |              |
| <p><b>CO1 :</b> explain the fundamentals of Artificial Intelligence and Machine Learning, types of learning, performance metrics, and dataset handling techniques including data preprocessing and train-test splitting.</p> <p><b>CO2 :</b> apply regression and classification algorithms to build models and evaluate their performance.</p> <p><b>CO3 :</b> analyze clustering methods and neural network models for pattern recognition and data analysis.</p> <p><b>CO4 :</b> explain ANN, DNN, CNN, RNN, LSTM fundamentals, back propagation, applications, and performance issues</p>                                                                                          |                 |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                    | <b>9 Hrs</b> |
| <p><b>Introduction to AI:</b> Definition, history, applications, advantages and limitations of AI</p> <p><b>Introduction to Machine Learning:</b> Definition, history, applications, advantages, types of learning - Supervised, Unsupervised and Reinforcement learning, ML workflow, underfitting &amp; overfitting, performance metrics for regression with <math>R^2</math> and Mean Squared Error and performance metrics for classification with Confusion Matrix, Accuracy, Precision, Recall and F1-score</p> <p><b>Datasets:</b> Types of datasets, dataset components, dataset formats, data exploration, handling missing values, feature scaling and train-test split.</p> |                 |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                    | <b>9 Hrs</b> |
| <p><b>Supervised Learning:</b> Regression - Simple linear regression, multiple linear regression, polynomial regression and model evaluation. Classification - Logistic regression, K-Nearest Neighbors, Naïve Bayes, Decision Trees, Random Forest, Support Vector Machines and kernelized Support Vector Machines</p>                                                                                                                                                                                                                                                                                                                                                                |                 |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                    | <b>9 Hrs</b> |
| <p><b>Unsupervised Learning:</b> Challenges in unsupervised learning, preprocessing and scaling, dimensionality reduction and feature extraction, principal component analysis and manifold learning - principal component analysis, non negative matrix factorization and manifold learning with t-SNE; Clustering - K-means clustering with elbow method, agglomerative clustering, DBSCAN, comparing and evaluating clustering algorithms</p>                                                                                                                                                                                                                                       |                 |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                    | <b>9 Hrs</b> |
| <p><b>Artificial Neural Networks (ANN):</b> Introduction, fundamentals of ANN, activation functions, perceptron model, feed forward neural networks, back propagation algorithm, applications, performance and issues, Deep Neural Networks, Convolutional Neural Network, Recurrent Neural</p>                                                                                                                                                                                                                                                                                                                                                                                        |                 |                    |              |

## Network and introduction to LSTMs

### TextBook(s):

1. Andreas C. Müller , Sarah Guido, *Introduction to Machine Learning with Python – A guide for data scientists*, O'Reilly Media, 1<sup>st</sup> edition, 2016, California.
2. Satish Kumar, *Neural Networks – A Classroom Approach*, McGraw Hill Education, 2<sup>nd</sup> edition, 2017, India.

### Reference Book(s):

1. Jiawei Han, Micheline Kamber, Jian Pei, *Data Mining: Concepts and Techniques*, 3<sup>rd</sup> edition, Morgan Kaufmann (Elsevier), 2012, USA.
2. Vinod Chandra S.S., Anand Hareendran S., *Artificial Intelligence and Machine Learning*, PHI Learning Private Limited, 2014, New Delhi.
3. Aurélien Geron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 2<sup>nd</sup> edition, O'Reilly Media, 2019, California.
4. B.Yegnarayana, *Artificial Neural Networks*, PHI, Standard edition, 2005, New Delhi.

### Web and Video link(s):

<https://www.youtube.com/watch?v=r4sgKrRL2Ys&list=PLVedk3nRvxDSQQpgMS6PBqV2IEeXJSLj>; NPTEL Video Lecture on Machine Learning by Prof. Balaraman Ravindran, Professor of Data Science and AI, IIT Madras.

| Course Articulation Matrix (CAM): |            |     |      | U24EC505 :ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING |      |      |     |     |     |      |      |      |      |      |
|-----------------------------------|------------|-----|------|--------------------------------------------------------|------|------|-----|-----|-----|------|------|------|------|------|
| CO                                |            | PO1 | PO2  | PO3                                                    | PO4  | PO5  | PO6 | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC505.1 | 3   | 2    | 1                                                      | 2    | 3    | -   | -   | -   | -    | 1    | 1    | 2    | 2    |
| CO2                               | U24EC505.2 | 3   | 3    | 2                                                      | 3    | 3    | -   | -   | -   | 1    | 1    | 1    | 3    | 3    |
| CO3                               | U24EC505.3 | 3   | 3    | 2                                                      | 3    | 2    | -   | -   | -   | 2    | -    | 1    | 3    | 2    |
| CO4                               | U24EC505.4 | 3   | 3    | 3                                                      | 3    | 3    | -   | -   | -   | 2    | 1    | 1    | 3    | 3    |
| U24EC505                          |            | 3   | 2.75 | 2                                                      | 2.75 | 2.75 | -   | -   | -   | 1.67 | 1    | 1    | 2.75 | 2.5  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |      |                                                        |      |      |     |     |     |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                          |              |                                         |                                                                                                                                                                                     |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                                                  | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                                               |
| CO1                     | Explain the fundamentals of Artificial Intelligence and Machine Learning, types of learning, performance metrics, and dataset handling techniques including data preprocessing and train-test splitting. | SDG4         | Quality Education                       | Understanding AI and ML fundamentals and data preprocessing equips students with essential digital and analytical skills, promoting quality education and lifelong learning.        |
| CO2                     | Apply regression and classification algorithms to build models and evaluate their performance                                                                                                            | SDG9         | Industry, Innovation and Infrastructure | Machine learning models such as regression and classification are widely used in industrial applications, enabling innovation, automation, and intelligent decision-making systems. |

| CO-SDG Alignment Matrix |                                                                                                       |                 |                                         |                                                                                                                                                                                   |
|-------------------------|-------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                               | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                             |
| CO3                     | Analyze clustering methods and neural network models for pattern recognition and data analysis        | SDG11           | Sustainable Cities and Communities      | Clustering and neural networks support smart city applications such as traffic management, surveillance, and urban planning through intelligent data analysis.                    |
| CO4                     | Explain ANN, DNN, CNN, RNN, LSTM fundamentals, back propagation, applications, and performance issues | SDG9            | Industry, Innovation and Infrastructure | Artificial Neural Networks support intelligent systems, automation, pattern recognition, and emerging AI technologies that promote innovation and advanced engineering solutions. |

## ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |                 |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------|--------------|
| <b>Class:</b> B.Tech. V Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Branch:</b> Common to all |                 |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | U24IK506A                    | <b>Credits:</b> | -            |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>2-0-0-2</b>               | <b>CIE:</b>     | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>24 Hrs</b>                | <b>ESE:</b>     | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i><br><b>CO1 :</b> summarize the basic structure of Vedas, Upavedas, Vedanga, Upanga<br><b>CO2 :</b> explain Vedas as principal source of knowledge for scientific inventions<br><b>CO3 :</b> describe different yogasanas, breathing techniques, chakras, meditation and their benefits<br><b>CO4 :</b> discuss the benefits of yoga as an effective tool for management of human crisis |                              |                 |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                 | <b>6 Hrs</b> |
| <b>Basic Structure of Indian Knowledge System:</b><br>Introduction, Vedas – origin, classification, structure, Rig Veda, Sama Veda, Yajur Veda, Atharva Veda, UpaVedas – DhanurVeda, SthapatVeda, GandharvaVeda, AyurVeda, Vedanga – Shiksha, Chanda, Vyakarna, Nirukta, Kalpa, Jyothisha, Upanga – Dharmashastra, Mimamsa, Tarkashastra, Purana                                                                                                                                                        |                              |                 |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |                 | <b>6 Hrs</b> |
| <b>Modern Science and Indian Knowledge System:</b><br>Introduction, Vedas as basis for modern science, architectural developments, medicine and its relevance, mathematical sciences in Vedas, space and military related developments, chemical sciences                                                                                                                                                                                                                                               |                              |                 |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |                 | <b>6 Hrs</b> |
| <b>Yoga and Holistic Health Care:</b><br>Healthy mind in healthy body, yoga: definition, types, yoga to keep fit: diet, yoga asanas, fundamentals, breathing techniques in Patanjali yoga tradition, pranayama, chakras, meditation, benefits of yoga – physical health, emotional health, prevention of disease, reducing or alleviating symptoms of problems.                                                                                                                                         |                              |                 |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |                 | <b>6 Hrs</b> |
| <b>Case Studies – Yoga Practice:</b><br>Yoga as an effective tool for management of human crisis – depression, self-concept & mental health, yoga for stress management, yoga: a way to cure for insomnia.<br><br>Requisite: Yoga practice sessions are to be conducted for all students taking this course by the time they complete Unit 1 and Unit 2.                                                                                                                                                |                              |                 |              |

**TextBook(s):**

1. Sathish Chandra Chatterjee, Dhirendramohan Datta, *An Introduction to Indian Philosophy*, New Delhi: Rupa Publications Pvt. Ltd. (Chapter 2, 3).
2. Priyadarajan Ray, S.N. Sen, *The Cultural Heritage of India*, Vol. 6, Science and Technology, Kolkata: The Ramakrishna Mission Institute of Culture.
3. *Yoga Sutra of Patanjali*, Kolkata: Ramakrishna Mission.
4. RN Jha, *Science of Consciousness Psychotherapy and Yoga Practices*, New Delhi: VidyanidhiPrakasham, 2016 (Chapter 4, 5, 6, 7, 8).

**Reference Book(s):**

1. Swami Jitatananda, *Holistic Science and Vedanta*, Mumbai: Bharatiya Vidya Bhavan (Chapter 2, 3).

**Web and Video link(s):**

1. NPTEL courses on Indian Philosophy, Yoga and Vedic Sciences available at <https://onlinecourses.nptel.ac.in>

| Course Articulation Matrix (CAM): |             |     | U26IK506A: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------|-------------|-----|----------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO                                |             | PO1 | PO2                                                | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1                               | U26IK506A.1 | -   | -                                                  | -   | -   | -   | 1   | -   | 2   | 1   | 1    | -    | -    | -    | -    |
| CO2                               | U26IK506A.2 | -   | -                                                  | -   | -   | -   | 1   | 1   | 2   | 1   | 1    | -    | -    | -    | -    |
| CO3                               | U26IK506A.3 | -   | -                                                  | -   | -   | -   | 1   | -   | 2   | 2   | 1    | -    | 2    | -    | -    |
| CO4                               | U26IK506A.4 | -   | -                                                  | -   | -   | -   | 1   | 1   | 2   | 2   | 1    | -    | 2    | -    | -    |
| U26IK506A                         |             | -   | -                                                  | -   | -   | -   | 1   | 1   | 2   | 1.5 | 1    | -    | 2    | -    | -    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |                                                    |     |     |     |     |     |     |     |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                            |                 |                                         |                                                                                                                                                                                                             |
|-------------------------|--------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                    | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                                       |
| CO1                     | summarize the basic structure of Vedas, Upavedas, Vedanga, Upanga                          | SDG4            | Quality Education                       | Understanding the foundational structure of Indian knowledge systems supports holistic education, critical thinking, and cultural literacy, contributing to quality and inclusive education.                |
| CO2                     | explain Vedas as principal source of knowledge for scientific inventions                   | SDG9            | Industry, Innovation and Infrastructure | Recognizing Vedic contributions to science and technology highlights indigenous innovation in areas such as mathematics, architecture and medicine, inspiring modern sustainable technological development. |
| CO3                     | describe different yogasanas, breathing techniques, chakras, meditation and their benefits | SDG3            | Good Health and Well-being              | Knowledge of yoga, pranayama, and meditation directly promotes physical health, mental well-being, and disease prevention, supporting the SDG goal of ensuring healthy                                      |

| CO-SDG Alignment Matrix |                                                                                  |                 |                            |                                                                                                                                                                                           |
|-------------------------|----------------------------------------------------------------------------------|-----------------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                          | Relevant<br>SDG | SDG<br>Description         | Mapping Justification                                                                                                                                                                     |
|                         |                                                                                  |                 |                            | lives for all.                                                                                                                                                                            |
| CO4                     | discuss the benefits of yoga as an effective tool for management of human crisis | SDG3            | Good Health and Well-being | Understanding yoga as a therapeutic tool for depression, stress, and insomnia contributes to mental health management and holistic wellness, aligning with SDG3 targets on mental health. |

| TECHNICAL ENGLISH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                                |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------|------|
| Class: B. Tech. V Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          | Branch: Common to all Branches |      |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | U24MH507 | Credits:                       | 1    |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0-0-2-2  | CIE:                           | 100% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 24 Hrs   | ESE:                           | -    |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the student should be able to,</i><br>C develop effective listening, speaking, reading and writing skills by understanding native-speaker conversations and expressing ideas clearly and confidently using appropriate vocabulary, while maintaining fluency, coherence and accurate pronunciation.<br>C enhance communication and professional writing skills through podcast comprehension, group discussions, resume and email writing<br>C develop the ability to understand reading texts, conversations of both native and non-native speakers, interpret visual information, and produce clear and well-structured technical reports.<br>C develop the ability to perform well in interviews and present effectively with clarity of speech and appropriate accent. |          |                                |      |
| <b>Activity-12hrs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |                                |      |
| <b>Phonetic Foundations, Authentic Audio-Visual Comprehension &amp; Vocabulary Enhancement:</b> Speech Sounds- Phonemes (Vowels and consonant sounds), word stress, syllables - their role and importance in spoken English, <b>Authentic Audio-Visual Comprehension:</b> Movie Clips - Screening of a short native-speaker clip - context comprehension, focus attention on accent features and key expressions, <b>Vocabulary:</b> Word Formation-Prefixes-Suffixes.<br><b>Activity:</b> Practice pronunciation through Read-Record-Reflect, analyze audio-visual content for comprehension and expression usage.                                                                                                                                                                                                                                     |          |                                |      |
| <b>Activity-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          | <b>2hrs</b>                    |      |
| <b>Story Narration, Writing Skills and Vocabulary Enhancement-</b> Narrative structure (beginning, build-up, climax, conclusion), Cohesive devices, Voice modulation & Expression. <b>Writing:</b> Principles of Paragraph Writing-Importance of Coherence in Writing-Cause and Effect Paragraphs. <b>Vocabulary:</b> Synonyms and antonyms.<br><b>Activity:</b> Narrate structured stories with peer interaction, Read-Record-Reflect storytelling activity for pronunciation and expression enhancement, Write a coherent cause and effect paragraph, Vocabulary practice exercises on synonyms and antonyms.                                                                                                                                                                                                                                         |          |                                |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>Activity -</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>2hrs</b> |
| <b>Reading Comprehension, Vocabulary Enhancement &amp; Elocution Skills- Reading Comprehension:</b> Main idea identification, interpretation, critical analysis. <b>Vocabulary Enhancement:</b> One-word substitutes. <b>Elocution:</b> Speech delivery skills (organisation, voice modulation, fluency, pronunciation, and audience engagement).<br><br><b>Activity:</b> Read and analyze passages for comprehension and critical interpretation, Read-Record-Reflect activity for improving reading fluency and pronunciation, Vocabulary exercises on one-word substitutes, and deliver a short speech with emphasis on clarity, confidence, and effective expression. |             |
| <b>Activity-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>2hrs</b> |
| <b>Think-Pair-Share Conversation (Podcast-Based), Vocabulary Enhancement:</b> Introduction to authentic spoken English through podcasts, listening for gist and specific information, and note-taking. Think-Pair-Share strategy, use of linking words and expressing agreement/disagreement politely<br><br><b>Vocabulary Enhancement:</b> Idioms in context and usage<br><br><b>Activity:</b> Listen to podcasts for comprehension and note-making, Think-Pair-Share discussions to exchange ideas and respond confidently, Speak-Record-Reflect activity for improving speaking fluency, pronunciation, and expression                                                 |             |
| <b>Activity-52hrs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |
| <b>Group Discussion, Vocabulary Enhancement:</b> GD format and roles, rules of participation, <b>Vocabulary</b> – Word Pairs, commonly confused words<br><br><b>Activity:</b> Engage in group discussions focusing on clear expression and interaction and word pair exercises                                                                                                                                                                                                                                                                                                                                                                                            |             |
| <b>Activity -62hrs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |
| <b>Reading Comprehension, Visual Interpretation &amp; Vocabulary Enhancement:</b> Skimming and scanning, identifying main and supporting ideas, distinguishing fact and opinion. <b>Visual Interpretation:</b> Interpreting visual cues, logical sequence. <b>Vocabulary:</b> Phrasal Verbs: separable and inseparable forms, and contextual usage.<br><br><b>Activity:</b> Engage in reading comprehension tasks for critical analysis, describe pictures ,Speak-Record-Reflect activity for improving fluency, pronunciation, and expression, and phrasal verbs practice exercises                                                                                      |             |
| <b>Activity-72hrs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <p><b>Motivational Speeches, Presentation Skills &amp; Vocabulary Enhancement:</b> identifying central theme and tone, note-taking, Narrative techniques. <b>Presentation</b> – Speak to Inspire- topic selection, structure (introduction-body-conclusion), <b>Vocabulary Enhancement</b> – Collocations- Introduction to collocations, types of collocations, and contextual usage</p> <p><b>Activity:</b> Listen to motivational speeches for comprehension and analysis, deliver a 3–5-minute inspirational presentation, Speak–Record–Replay activity for improving fluency, pronunciation, and expression, and collocations practice exercises</p> |             |
| <b>Activity-82hrs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |
| <p><b>Writing &amp; Vocabulary Enhancement:</b> Professional Resume Writing techniques, Action verbs in resume writing, Letter of Application, E-mail Etiquette—vocabulary: Jumbled sentences</p> <p><b>Activity:</b> Prepare a professional resume using an appropriate format and action verbs, write a letter of application and formal e-mail following etiquette and jumbled sentence exercises</p>                                                                                                                                                                                                                                                 |             |
| <b>Activity-92hrs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |
| <p><b>Reading Comprehension, Newspaper Reading &amp; Vocabulary Enhancement:</b> Intensive reading , Extensive reading, Newspaper reading:5W1H method, Summarization, vocabulary building</p> <p><b>Activity:</b> Reading comprehension exercises, Summarizing news content, discussion of current events, Speak–Record–Replay activity for improving fluency, pronunciation and expression. Vocabulary building through contextual usage from news articles</p>                                                                                                                                                                                         |             |
| <b>Activity-10</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>2hrs</b> |
| <p><b>PowerPoint Presentations:</b> Concept and purpose of presentations, layout and structure (title, introduction-body-conclusion), slide design elements, visual aids, common mistakes to avoid</p> <p><b>Activity:</b> Design and present a poster or PowerPoint presentation on a given topic, Speak–Record–Replay activity for improving fluency, pronunciation and expression, peer interaction and feedback sessions</p>                                                                                                                                                                                                                         |             |

|    |                                                                                                                                                                                                                                                            |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | <a href="https://www.youtube.com/watch?v=5SfQhkMsUFk&amp;list=PLA71NLNvxTzig5dqfGl8DGBLOvUI08yXg&amp;index=2">https://www.youtube.com/watch?v=5SfQhkMsUFk&amp;list=PLA71NLNvxTzig5dqfGl8DGBLOvUI08yXg&amp;index=2</a>                                      |
| 2. | Learn English with WRECK-IT RALPH<br><a href="https://www.youtube.com/watch?v=wVhG59zh4uQ&amp;list=PLA71NLNvxTzig5dqfGl8DGBLOvUI08yXg&amp;index=4">https://www.youtube.com/watch?v=wVhG59zh4uQ&amp;list=PLA71NLNvxTzig5dqfGl8DGBLOvUI08yXg&amp;index=4</a> |
| 3. | The Pursuit of Happiness (2006): Most Powerful Moments!<br><a href="https://www.youtube.com/watch?v=TkD1QvjKlqU">https://www.youtube.com/watch?v=TkD1QvjKlqU</a>                                                                                           |
| 4. | Podcast by Raul John "Inside the Mind of India's AI Kid". Business Today<br><a href="https://www.youtube.com/watch?v=biCrllhZrC4">https://www.youtube.com/watch?v=biCrllhZrC4</a>                                                                          |
| 5. | Podcast by Sudha Murthy - So What If I Lost the Battle, I Lived the War   The Ranveer Show<br><a href="https://www.youtube.com/watch?v=KwXtalUuhLc">https://www.youtube.com/watch?v=KwXtalUuhLc</a>                                                        |
| 6. | Motivational Talk by Gour Gopal Das, SLEEPLESS Nights for Overnight SUCCESS<br><a href="https://www.youtube.com/watch?v=YyCXp_E4sMU">https://www.youtube.com/watch?v=YyCXp_E4sMU</a>                                                                       |
| 7. | Motivational Talk by Admiral McRaven's Speech for Your Day, "5 Minutes to Start Your Day Right! - MORNING MOTIVATION"<br><a href="https://www.youtube.com/watch?v=b-Pn0yXL9y8">https://www.youtube.com/watch?v=b-Pn0yXL9y8</a>                             |

#### Laboratory Manual:

1. Technical English Manual prepared by the faculty of English, KITSW.

| Course Articulation Matrix (CAM): |                                                                                                                                  |              |     | U24MH507: Technical English |     |                                                                                                                                                                                                                        |     |     |     |     |      |      |      |      |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------|--------------|-----|-----------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|------|------|------|------|
| CO                                |                                                                                                                                  | PO1          | PO2 | PO3                         | PO4 | PO5                                                                                                                                                                                                                    | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24MH507.1                                                                                                                       | -            | -   | -                           | -   | -                                                                                                                                                                                                                      | -   | -   | -   | 2   | -    | 2    | -    | -    |
| CO2                               | U24MH507.2                                                                                                                       | -            | -   | -                           | -   | -                                                                                                                                                                                                                      | -   | -   | 2   | 2   | -    | 2    | -    | -    |
| CO3                               | U24MH507.3                                                                                                                       | -            | -   | -                           | -   | -                                                                                                                                                                                                                      | -   | -   | -   | 2   | -    | 2    | -    | -    |
| CO4                               | U24MH507.4                                                                                                                       | -            | -   | -                           | -   | -                                                                                                                                                                                                                      | -   | -   | 2   | 2   | -    | 2    | -    | -    |
| U24MH507                          |                                                                                                                                  | -            | -   | -                           | -   | -                                                                                                                                                                                                                      | -   | -   | 2   | 2   | -    | 2    | -    | -    |
| 3-HIGH, 2-MEDIUM, 1-LOW           |                                                                                                                                  |              |     |                             |     |                                                                                                                                                                                                                        |     |     |     |     |      |      |      |      |
| CO-SDG Alignment Matrix           |                                                                                                                                  |              |     |                             |     |                                                                                                                                                                                                                        |     |     |     |     |      |      |      |      |
| CO                                | CO Statement                                                                                                                     | Relevant SDG |     | SDG Description             |     | Mapping Justification                                                                                                                                                                                                  |     |     |     |     |      |      |      |      |
| CO1                               | The students should be able to develop effective listening, speaking, reading and writing skills by understanding native-speaker | SDG4         |     | Quality Education           |     | This aligns with SDG-4 as it develops effective listening, speaking, reading and writing skills that enable learners to understand native-speakers communication and communicate clearly and fluently with appropriate |     |     |     |     |      |      |      |      |

|     |                                                                                                                                                                                              |          |                                                     |                                                                                                                                                                                                                                                                                                                                                                      |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | conversations and expressing ideas clearly and confidently using appropriate vocabulary, while maintaining fluency, coherence and accurate pronunciation.                                    |          |                                                     | vocabulary and pronunciation to promote quality education                                                                                                                                                                                                                                                                                                            |
| CO2 | enhance communication and professional writing skills through podcast comprehension, group discussions, resume writing and Quality Education email writing                                   | SDG 4, 8 | Quality Education & Decent work and Economic growth | This aligns with SDG-4 as it promotes quality education by enhancing employability skills and professional writing skills through podcast comprehension, resume writing, critical reading and group discussion<br>This aligns with SDG-8 as it helps students expect productive employment and decent work opportunities by fostering academic and creative thinking |
| CO3 | develop the ability to understand reading texts, conversations of both native and non-native speakers, interpret visual information, and produce clear and well-structured technical reports | SDG 4    | Quality Education                                   | This aligns with SDG-4 as it develops the ability to interpret visual information and produce clear and well-structured technical reports for academic and professional contexts                                                                                                                                                                                     |
| CO4 | develop the ability to present effectively with clarity of speech and appropriate accent                                                                                                     | SDG 4    | Quality Education                                   | This aligns with SDG-4 as it enhances effective presentation skills and perform well in interviews                                                                                                                                                                                                                                                                   |

| <b>MICROCONTROLLERS AND APPLICATIONS LABORATORY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. V – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>U24EC508</b> | <b>Credits:</b>    | <b>1</b>   |
| <b>Hours/Week (L-T-P- E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>0-0-2-2</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>24Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |
| <b>Course Learning Outcomes (COs)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                    |            |
| <i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                    |            |
| <p><b>CO1:</b> Analyze and execute 8051 microcontroller assembly language programs for arithmetic, data manipulation, sorting, searching, and code conversion operations.</p> <p><b>CO2 :</b> Design and implement ARM7TDMI assembly language programs for arithmetic computations, data processing, and mathematical problem solving.</p> <p><b>CO3:</b> Develop embedded applications using LPC2148 for GPIO-based interfacing and control of LEDs, buzzers, and digital I/O devices.</p> <p><b>CO4:</b> Design and implement real-time embedded control applications using LPC2148 for interfacing and controlling stepper motors.</p> |                 |                    |            |
| <b>Hardware Experiments:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |                    |            |
| <b>Experiments-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                    |            |
| 1. Microcontroller 8051 based Assembly language programs for simple 8-bit Arithmetic operations (Addition, Subtraction, Multiplication and Division).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                    |            |
| <b>Experiments-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                    |            |
| 2. Microcontroller 8051 based Assembly language programs to find largest/Smallest Number in an array                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                    |            |
| <b>Experiments-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                    |            |
| 3. Microcontroller 8051 based Assembly language programs to sort given series of numbers in Ascending/Descending order                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                    |            |
| <b>Experiment-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 4. Microcontroller 8051 based Assembly language programs to transfer of byte from one location to another.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                    |            |
| <b>Experiment-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 5. Microcontroller 8051 based Assembly language program for Code Conversion Program Hexa decimal to ASCII.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                    |            |
| <b>Experiment-6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 6. ARM7TDMI based Assembly language programs to perform simple 8-bit Arithmetic operations (Addition, Subtraction, Multiplication and Division).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                    |            |
| <b>Experiment-7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 7. ARM7TDMI based Assembly language program to perform Swapping of two Number & finding factorial of given number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                    |            |
| <b>Experiment-8</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 8. ARM7TDMI based Assembly language program to evaluate linear equation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |                    |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Experiment-9</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 9. Write a program for Flashing of LEDs using LPC2148.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Experiment-10</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 10. Write a Program to interface Buzzer using LPC2148                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Experiment-11</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 11. Write a Program to interface Digital I/O Using LPC2148                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Experiment-12</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 12. Write a program to Interface stepper motor using LPC2148                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Textbook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. K. J. Ayala, D. V. <i>The 8051 Microcontroller &amp; Embedded Systems using Assembly and C</i>, Gadre, Cengage Learning (Chapters 1 to 7, 9 to 12)</li> <li>2. Sloss, Andrew, Dominic Symes, and Chris Wright. <i>ARM system developer's guide: designing and optimizing system software</i>. Elsevier, 2004.</li> <li>3. LPC2148 User manual</li> </ol>                                                                                                                                                                       |
| <b>Reference Book(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <ol style="list-style-type: none"> <li>1. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay <i>the 8051 Microcontroller and Embedded Systems Using Assembly and C</i>, 2nd Edition, Pearson Education</li> <li>2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", TMH Publications, Second Edition, 2008.</li> <li>3. Furber, Stephen Bo. <i>ARM system-on-chip architecture</i>, New Delhi: Pearson Education, 2000.</li> <li>4. Predko M., <i>Programming and Customizing the 8051 Microcontroller</i>, McGraw-Hill, 1999</li> </ol> |
| <b>Web and Video link(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <ol style="list-style-type: none"> <li>1. <a href="https://www.youtube.com/watch?v=qWqlkCLmZoE&amp;utm_source=chatgpt.com">https://www.youtube.com/watch?v=qWqlkCLmZoE&amp;utm_source=chatgpt.com</a></li> <li>2. <a href="http://www.digimat.in/nptel/courses/video/117106111/L03.html">http://www.digimat.in/nptel/courses/video/117106111/L03.html</a></li> <li>3. <a href="https://www.youtube.com/playlist?list=PLbMVogVj5nJRDS4w20GO7l4SepLhuAj9X">https://www.youtube.com/playlist?list=PLbMVogVj5nJRDS4w20GO7l4SepLhuAj9X</a></li> </ol>                         |
| <b>Laboratory Manual:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| MICROPROCESSORS AND APPLICATIONS LABORATORY, Department of ECE, KITSW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Course Articulation Matrix (CAM): |            |     |     | U24EC508 :MICROPROCESSORS AND APPLICATIONS LABORATORY |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|-------------------------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                                                   | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC508.1 | 3   | 2   | 2                                                     | 1    | 3   | -   | -   | -   | 2   | -    | -    | 2    | 2    |
| CO2                               | U24EC508.2 | 3   | 3   | 2                                                     | 2    | 3   | -   | -   | -   | 1   | -    | -    | 2    | 2    |
| CO3                               | U24EC508.3 | 2   | 2   | 3                                                     | 2    | 3   | -   | -   | -   | 2   | -    | -    | 2    | 2    |
| CO4                               | U24EC508.4 | 2   | 3   | 3                                                     | 2    | 3   | -   | -   | -   | 1   | -    | -    | 2    | 2    |
| U24EC508                          |            | 2.5 | 2.5 | 2.5                                                   | 1.75 | 3   | -   | -   | -   | 1.5 | -    | -    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                                       |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                            |                 |                                         |                                                                                                                                                                                                                                                                                                       |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                    | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                                                                                                                                 |
| CO1                     | Analyze and execute 8051 microcontroller assembly language programs for arithmetic, data manipulation, sorting, searching, and code conversion operations. | SDG 4           | Quality Education                       | Develops fundamental programming and microcontroller skills through hands-on laboratory exercises. Students gain practical knowledge of embedded system programming, problem-solving, and computational thinking, thereby supporting quality technical education and lifelong learning opportunities. |
| CO2                     | Design and implement ARM7TDMI assembly language programs for arithmetic computations, data processing, and mathematical problem solving.                   | SDG 4           | Quality Education                       | enhances learners' understanding of advanced microcontroller architectures and assembly language programming. The practical implementation of computational algorithms strengthens technical competencies and industry-relevant skills, directly contributing to quality engineering education...     |
| CO3                     | Develop embedded applications using LPC2148 for GPIO-based interfacing and control of LEDs, buzzers, and digital I/O devices.                              | SDG 9           | Industry, Innovation and Infrastructure | focuses on embedded hardware interfacing and real-time control applications, which are essential for industrial automation and smart electronic systems. It promotes innovation in embedded product development and supports the advancement of modern technological infrastructure.                  |
| CO4                     | Design and implement real-time embedded control applications using LPC2148 for interfacing and controlling stepper motors.                                 | SDG 9           | Industry, Innovation and Infrastructure | develop automation and motor-control solutions widely used in manufacturing, robotics, and industrial systems. The acquired skills foster innovation and contribute to the development of sustainable industrial infrastructure and intelligent control technologies                                  |

| <b>VLSI DESIGN LABORATORY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                    |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. V – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>U24EC509</b> | <b>Credits:</b>    | <b>1</b>   |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>0-0-2-2</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>24Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                          |                 |                    |            |
| <b>CO1 :</b> Analyze the characteristics and operation of MOSFET and basic CMOS inverter.<br><b>CO2 :</b> Design and verify the functionality of CMOS logic gates using schematic and layout design techniques.<br><b>CO3 :</b> Design and verify the functionality of CMOS combinational circuits using schematic and layout design techniques.<br><b>CO4 :</b> Design and analyze the common source amplifiers, current mirrors, and basic differential amplifiers using MOS schematic. |                 |                    |            |
| <b>Experiment-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 1. MOSFET characterization using cadence EDA.                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                    |            |
| <b>Experiment-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 2. Schematic of CMOS inverter and its VTC analysis                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                    |            |
| <b>Experiment-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 3. Design of CMOS NAND gate Schematic and its analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                   |                 |                    |            |
| <b>Experiment-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 4. Design of CMOS NOR gate Schematic and its analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                    |            |
| <b>Experiment-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 5. Layout design CMOS inverter and its analysis                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                    |            |
| <b>Experiment-6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 6. Layout design CMOS NAND/NOR gate and its analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                    |            |
| <b>Experiment-7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 7. Design and Implementation of a Half Adder Using CMOS Logic with Schematic Diagram.                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                    |            |
| <b>Experiment-8</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 8. Design of 4:1 mux using pass transistor logic.                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                    |            |
| <b>Experiment-9</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |            |
| 9. Design and Analysis of a Common Source Amplifier with Schematic Diagram.                                                                                                                                                                                                                                                                                                                                                                                                               |                 |                    |            |
| <b>Experiment-10</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                    |            |
| 10. Design and Analysis of a Basic Current Mirror with Schematic Diagram.                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                    |            |
| <b>Experiment-11</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                    |            |
| 11. Design and Analysis of multistage amplifier.                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                    |            |

**Experiment-12**

12. Design and Analysis of a Basic Differential amplifier with Schematic Diagram.

**TextBook(s):**

1. Douglas A Pucknell and Kamran Eshraghian, Basic VLSI Design, 3rd ed., New Delhi: PHI, 2008. (Chapters 1 to 6)
2. Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2nd Edition, Tata McGraw-Hill, 2017

**Reference Book(s):**

1. Neil H. E. Weste, David Harris and Ayan Banerjee, CMOS VLSI Design – A Circuits and Systems Perspective, 3rd ed., New Delhi: Pearson Education, 2005.
2. CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, 3rd Edition, Tata McGraw-Hill, 2011
3. Digital Integrated Circuits – A Design Perspective, Jan M. Rabaey, AnanthaChandrakasan, Borivoje Nikolic, 2nd Edition, PHI, 2016.

**Laboratory Manual:**

1. VLSI design Laboratory Manual, Department of ECE, KITSW

| Course Articulation Matrix (CAM): |            |     |     | U24EC509: VLSI DESIGN LABORATORY |     |      |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|----------------------------------|-----|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                              | PO4 | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC509.1 | 2   | 2   | 2                                | 1   | 2    | -   | 1   | 1   | 1   | -    | 1    | 2    | 2    |
| CO2                               | U24EC509.2 | 2   | 2   | 2                                | 2   | 2    | 1   | 1   | 1   | -   | -    | 1    | 2    | 2    |
| CO3                               | U24EC509.3 | 2   | 2   | 2                                | 2   | 2    | 1   | -   | 1   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC509.4 | 2   | 2   | 3                                | 3   | 3    | 1   | 1   | 1   | -   | -    | 2    | 2    | 2    |
| U24EC509                          |            | 2   | 2   | 2.25                             | 2   | 2.25 | 1   | 1   | 1   | 1   | -    | 1.5  | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                  |     |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                  |                 |                                         |                                                                                                                                                                                  |
|-------------------------|------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to</i>                                                             | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                            |
| CO1                     | Analyze the characteristics and operation of MOSFET and basic CMOS inverter.                                     | SDG9            | Industry, Innovation and Infrastructure | Analysis of MOSFET characteristics and CMOS inverter operation using EDA tools supports semiconductor technology development and electronic infrastructure innovation.           |
| CO2                     | Design and verify the functionality of CMOS logic gates using schematic and layout design techniques.            | SDG9            | Industry, Innovation and Infrastructure | Design and verification of CMOS logic gates using schematic and layout design techniques contribute to VLSI system development and modern digital infrastructure.                |
| CO3                     | Design and verify the functionality of CMOS combinational circuits using schematic and layout design techniques. | SDG7            | Affordable and Clean Energy             | Design and verification of CMOS combinational circuits using schematic and layout design techniques support the development of low-power and energy-efficient VLSI systems.      |
| CO4                     | Design and analyze the common source amplifiers, current mirrors, and basic                                      | SDG9            | Industry, Innovation and Infrastructure | Design and analysis of common source amplifiers, current mirrors, and basic differential amplifiers using Cadence EDA tools contribute to advancements in analog VLSI design and |

| CO-SDG Alignment Matrix |                                                                     |                 |                    |                                       |
|-------------------------|---------------------------------------------------------------------|-----------------|--------------------|---------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to</i>                | Relevant<br>SDG | SDG<br>Description | Mapping Justification                 |
|                         | differential amplifiers using MOS schematic with Cadence EDA tools. |                 |                    | semiconductor technology development. |

# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LABORATORY

|                                                                                                                                                                                                                 |                 |                    |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. V – Semester                                                                                                                                                                             |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                                                                                                                                                                                             | <b>U24EC510</b> | <b>Credits:</b>    | <b>1</b>   |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                    | <b>0-0-2-2</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                          | <b>24Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                |                 |                    |            |
| <b>CO1:</b> develop python programs to perform data handling, preprocessing, and visualization using NumPy, Pandas and Matplotlib.                                                                              |                 |                    |            |
| <b>CO2:</b> implement regression and classification algorithms to build machine learning models and analyze their performance.                                                                                  |                 |                    |            |
| <b>CO3:</b> apply clustering techniques and neural network models for pattern recognition and data analysis.                                                                                                    |                 |                    |            |
| <b>CO4:</b> develop neural network programs using activation functions, perceptron, feed forward networks, and back propagation for pattern classification applications.                                        |                 |                    |            |
| <b>Experiment-1</b>                                                                                                                                                                                             |                 |                    |            |
| 1. Develop a program to create and perform operations on NumPy arrays.<br>2. Develop a program to demonstrate array indexing and slicing.<br>3. Develop a program to perform mathematical operations on arrays. |                 |                    |            |
| <b>Experiment-2</b>                                                                                                                                                                                             |                 |                    |            |
| 1. Develop a program to create and manipulate Pandas DataFrames.<br>2. Develop a program to handle missing values using Pandas.<br>3. Develop a program to split dataset into training and testing sets.        |                 |                    |            |
| <b>Experiment-3</b>                                                                                                                                                                                             |                 |                    |            |
| 1. Develop a program to implement simple linear regression.                                                                                                                                                     |                 |                    |            |
| <b>Experiment-4</b>                                                                                                                                                                                             |                 |                    |            |
| 1. Develop a program to implement multiple linear regression.<br>2. Develop a program to implement polynomial regression.                                                                                       |                 |                    |            |
| <b>Experiment-5</b>                                                                                                                                                                                             |                 |                    |            |
| 1. Develop a program to implement logistic regression.<br>2. Develop a program to implement K-Nearest Neighbors (KNN).                                                                                          |                 |                    |            |
| <b>Experiment-6</b>                                                                                                                                                                                             |                 |                    |            |
| 1. Develop a program to implement Naïve Bayes classifier.<br>2. Develop a program to implement Decision Tree classifier.                                                                                        |                 |                    |            |
| <b>Experiment-7</b>                                                                                                                                                                                             |                 |                    |            |

1. Develop a program to implement Random Forest classifier.
2. Develop a program to implement Support Vector Machine (SVM).

#### **Experiment-8**

1. Develop a Python program to determine optimal clusters using elbow method.
2. Develop a Python program to implement K-means clustering.

#### **Experiment-9**

1. Develop a Python program to implement Principal Component Analysis (PCA).
2. Develop a Python program to reduce dataset dimensions using PCA and visualize the transformed data.
3. Develop a Python program to demonstrate feature extraction using PCA.

#### **Experiment-10**

1. Develop a program to demonstrate basic activation functions such as Sigmoid, Tanh and ReLU..
2. Develop a program to implement perceptron model for simple logic gates.

#### **Experiment-11**

1. Develop a program to demonstrate single-layer feed forward neural network.
2. Develop a program to implement multi-layer feed forward neural network.

#### **Experiment-12**

1. Develop a program to demonstrate back propagation algorithm for weight updation.
2. Develop a program to train a neural network for simple pattern classification.

#### **TextBook(s):**

1. Andreas C. Müller , Sarah Guido, *Introduction to Machine Learningwith Python – A guide for data scientists*, O'Reilly Media, 1<sup>st</sup> edition, 2016, California.
2. Satish Kumar, *Neural Networks – A Classroom Approach*, McGraw Hill Education, 2<sup>nd</sup> edition, 2017, India.

#### **Reference Book(s):**

1. Jiawei Han, Micheline Kamber, Jian Pei, *Data Mining: Concepts and Techniques*, 3<sup>rd</sup> edition, Morgan Kaufmann (Elsevier), 2012, USA.
2. Vinod Chandra S.S., Anand Hareendran S., *Artificial Intelligence and Machine Learning*, PHI Learning Private Limited, 2014, New Delhi.
3. AurélienGéron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 2<sup>nd</sup> edition, O'Reilly Media, 2019, California.
4. B.Yegnarayana, *Artificial Neural Networks*, PHI, Standard edition, 2005, New Delhi.

#### **Web and Video link(s):**

<https://www.youtube.com/watch?v=r4sgKrRL2Ys&list=PLVedk3nRvxDScQQpgMS6PBqV2IEeXJSLj>; NPTEL Video Lecture on Machine Learning by Prof. Balaraman Ravindran, Professor of Data Science and AI, IIT Madras.

**Laboratory Manual:**

1. *Artificial Intelligence and Machine Learning Laboratory Manual*, Department of ECE, KITSW

| Course Articulation Matrix (CAM): |            |     |     | U24EC510 :ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LABORATORY |     |      |     |     |     |      |      |      |      |      |
|-----------------------------------|------------|-----|-----|-------------------------------------------------------------------|-----|------|-----|-----|-----|------|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                                                               | PO4 | PO5  | PO6 | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC510.1 | 3   | 2   | 1                                                                 | 2   | 3    | -   | -   | -   | -    | 1    | 1    | 2    | 2    |
| CO2                               | U24EC510.2 | 3   | 3   | 2                                                                 | 3   | 3    | -   | -   | -   | 1    | 1    | 1    | 3    | 3    |
| CO3                               | U24EC510.3 | 3   | 3   | 2                                                                 | 3   | 2    | -   | -   | -   | 2    | -    | 1    | 3    | 2    |
| CO4                               | U24EC510.4 | 3   | 3   | 3                                                                 | 3   | 3    | -   | -   | -   | 2    | 1    | 1    | 3    | 3    |
| U24EC510                          |            | 3   | 3   | 2.75                                                              | 2   | 2.75 | -   | -   | -   | 1.67 | 1    | 1    | 2.75 | 2.75 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                                                   |     |      |     |     |     |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                              |                 |                                         |                                                                                                                                                                                     |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                      | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                               |
| CO1                     | develop Python programs to perform data handling, preprocessing, and visualization using NumPy, Pandas and Matplotlib.                                       | SDG4            | Quality Education                       | Understanding AI and ML fundamentals and data preprocessing equips students with essential digital and analytical skills, promoting quality education and lifelong learning.        |
| CO2                     | implement regression and classification algorithms to build machine learning models and analyze their performance.                                           | SDG9            | Industry, Innovation and Infrastructure | Machine learning models such as regression and classification are widely used in industrial applications, enabling innovation, automation, and intelligent decision-making systems. |
| CO3                     | apply clustering techniques and neural network models for pattern recognition and data analysis.                                                             | SDG11           | Sustainable Cities and Communities      | Clustering and neural networks support smart city applications such as traffic management, surveillance, and urban planning through intelligent data analysis.                      |
| CO4                     | develop neural network programs using activation functions, perceptron, feed forward networks, and back propagation for pattern classification applications. | SDG9            | Industry, Innovation and Infrastructure | Artificial Neural Networks support intelligent systems, automation, pattern recognition, and emerging AI technologies that promote innovation and advanced engineering solutions.   |

| SEMINAR                                                                                                                                                                                                                          |          |             |      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|------|
| Class: B. Tech. V – Semester                                                                                                                                                                                                     |          | Branch: ECE |      |
| Course Code:                                                                                                                                                                                                                     | U24EC511 | Credits:    | 1    |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                            | 0-0-2-2  | CIE:        | 100% |
| Total Number of Teaching Hours:                                                                                                                                                                                                  | -        | ESE:        | -    |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                 |          |             |      |
| CO1 select current topics in their engineering discipline & allied areas from peer reviewed journals / technical magazines/ conference proceedings                                                                               |          |             |      |
| CO2 demonstrate the skills for performing a literature survey, identify gaps, analyze the technical content and prepare a well-documented seminar report                                                                         |          |             |      |
| CO3 create informative PPT and demonstrate communication skills through effective oral presentation showing knowledge on the subject & sensitivity towards social impact of the seminar topic                                    |          |             |      |
| CO4 write a “seminar paper” in scientific journal style & format from the prepared seminar report                                                                                                                                |          |             |      |
| <i>Student has to give an independent seminar on the state-of-the-art technical topics relevant to their program of study, which would supplement and complement the program assigned to each student.</i>                       |          |             |      |
| <b>Guidelines:</b>                                                                                                                                                                                                               |          |             |      |
| 1. The HoD shall constitute a Department Seminar Evaluation Committee (DSEC)                                                                                                                                                     |          |             |      |
| 2. DSEC shall allot a faculty supervisor to each student for guiding on (i) selection of topic(ii)literature survey and work to be carried out (iii) preparing a report in proper format, and (iv)effective seminar presentation |          |             |      |
| 3. There shall be only Continuous Internal Evaluation (CIE) for seminar                                                                                                                                                          |          |             |      |
| 4. The CIE for seminar is as follows:                                                                                                                                                                                            |          |             |      |
| Assessment                                                                                                                                                                                                                       |          | Weightage   |      |
| Seminar Supervisor Assessment                                                                                                                                                                                                    |          | 20%         |      |
| Seminar Report                                                                                                                                                                                                                   |          | 30%         |      |
| SDG Alignment                                                                                                                                                                                                                    |          | 10%         |      |
| DSEC Assessment: Oral presentation with PPT and viva-voce                                                                                                                                                                        |          | 40%         |      |
| Total Weightage:                                                                                                                                                                                                                 |          | 100%        |      |
| <b>Note:</b> It is mandatory for the student to appear for oral presentation and viva-voce to qualify for course evaluation                                                                                                      |          |             |      |
| (h) <b>Seminar Topic:</b> The topic should be interesting and conducive to discussion. Topics may be found by looking through recent issues of peer reviewed Journals / Technical Magazines on the topics of potential interest. |          |             |      |
| (i) <b>Report:</b> Each student is required to submit a well-documented report on the chosen seminar topic as per the format specified by DSEC.                                                                                  |          |             |      |
| (j) <b>Anti-Plagiarism Check:</b> The seminar report should clear the plagiarism check as per the Anti-Plagiarism (including AI Plagiarism) policy of the institute.                                                             |          |             |      |
| (k) <b>Presentation:</b> Each student should prepare a PPT with informative slides and make an effective oral presentation before the DSEC as per the schedule notified by the                                                   |          |             |      |

department.

- (l) The student has to register for the Seminar as a supplementary examination in the following cases:
  - iv) The student is absent for oral presentation and viva-voce
  - v) The student fails to submit the report in prescribed format
  - vi) The student fails to fulfill the requirements of seminar evaluation as per specified guidelines.
  - vii) The CoE shall send a list of students registered for supplementary to the HoD concerned
  - viii) The DSEC, duly constituted by the HoD, shall conduct seminar evaluation and send the award list to the CoE within the stipulated time

| Course Articulation Matrix (CAM): |            |     | U24EC511: SEMINAR |     |     |     |      |      |      |      |      |      |      |      |
|-----------------------------------|------------|-----|-------------------|-----|-----|-----|------|------|------|------|------|------|------|------|
| CO                                |            | PO1 | PO2               | PO3 | PO4 | PO5 | PO6  | PO7  | PO8  | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC511.1 | 2   | 2                 | -   | 2   | 2   | 1    | 1    | -    | 1    | -    | 3    | 1    | 1    |
| CO2                               | U24EC511.2 | 2   | 3                 | 1   | 3   | 2   | 1    | 1    | 1    | 2    | -    | 3    | 1    | 1    |
| CO3                               | U24EC511.3 | 1   | 1                 | 1   | 1   | 2   | 2    | 1    | 2    | 3    | 1    | 2    | 1    | 1    |
| CO4                               | U24EC511.4 | 1   | 2                 | 1   | 2   | 2   | 1    | 2    | 1    | 3    | -    | 2    | 1    | 1    |
| U24EC511                          |            | 1.5 | 2                 | 1   | 2   | 2   | 1.25 | 1.25 | 1.33 | 2.33 | 1    | 2.5  | 1    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |                   |     |     |     |      |      |      |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                           |              |                                         |                                                                                                                                                                                                                                                                |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                                                                                                                           | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                                                                                                                          |
| CO1                     | select current topics in their engineering discipline & allied areas from peer reviewed journals / technical magazines/ conference proceedings                                            | SDG 4        | Quality Education                       | Identifying and studying emerging ECE technologies such as 6G communications, VLSI, IoT, Artificial Intelligence, Embedded Systems, and Signal Processing promotes self-directed learning, technical competency, and continuous knowledge acquisition.         |
| CO2                     | demonstrate the skills for performing literature survey, identify gaps, analyze the technical content and prepare a well-documented seminar report                                        | SDG 9        | Industry, Innovation and Infrastructure | Literature review and technical analysis of advanced communication systems, semiconductor technologies, smart electronics, and intelligent networks foster innovation, research culture, and technological infrastructure development.                         |
| CO3                     | create informative PPT and demonstrate communication skills through effective oral presentation showing knowledge on the subject & sensitivity towards social impact of the seminar topic | SDG 11       | Sustainable Cities and Communities      | Seminar presentations on smart cities, intelligent transportation systems, IoT-enabled urban services, disaster management systems, and smart communication networks highlight the role of ECE technologies in building sustainable and connected communities. |

| CO-SDG Alignment Matrix |                                                                                               |              |                                        |                                                                                                                                                                                                                   |
|-------------------------|-----------------------------------------------------------------------------------------------|--------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                               | Relevant SDG | SDG Description                        | Mapping Justification                                                                                                                                                                                             |
| CO4                     | write a "seminar paper" in scientific journal style & format from the prepared seminar report | SDG 12       | Responsible Consumption and Production | Preparation of technical papers promotes ethical dissemination of research findings, proper citation practices, responsible use of information resources, and documentation of sustainable engineering solutions. |

# 6<sup>th</sup> Semester Syllabus

## VI SEMESTER

| S. No.                                                                                                                                                    | Category | Course Code | Course Title                                          | Lectures / week |   |   |    | Credits |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|-------------------------------------------------------|-----------------|---|---|----|---------|
|                                                                                                                                                           |          |             |                                                       | L               | T | P | E  | C       |
| 1                                                                                                                                                         | OEC      | U24OE601    | Open Elective - II                                    | 2               | 1 | - | 3  | 3       |
| 2                                                                                                                                                         | PEC      | U24EC602    | Program Elective -I / MOOCs-I                         | 2               | 1 | - | 3  | 3       |
| 3                                                                                                                                                         | PCC      | U24EC603    | Digital Signal Processing and Applications            | 2               | 1 | - | 3  | 3       |
| 4                                                                                                                                                         | PCC      | U24EC604    | System Verilog for Design and Verification            | 2               | 1 | - | 3  | 3       |
| 5                                                                                                                                                         | PCC      | U24EC605    | Antennas and Wave Propagation                         | 2               | 1 | - | 3  | 3       |
| 6                                                                                                                                                         | IKSC     | U24IK606B   | Universal Human Values-II                             | 2               | - | - | 2  | 2       |
| 7                                                                                                                                                         | PCC      | U24EC607    | Digital Signal Processing and Applications Laboratory | -               | - | 2 | 2  | 1       |
| 8                                                                                                                                                         | PCC      | U24EC608    | System Verilog for Design and Verification Laboratory | -               | - | 2 | 2  | 1       |
| 9                                                                                                                                                         | SEC      | U24SE609    | Programming Skill Development Lab -4                  | -               | - | 2 | 2  | 1       |
| 10                                                                                                                                                        | ELC      | U24EC610    | Mini Project                                          | -               | - | 2 | 2  | 1       |
| Total:                                                                                                                                                    |          |             |                                                       | 12              | 5 | 8 | 25 | 21      |
| Additional Learning@:Maximum credits allowed for Honours/Minor                                                                                            |          |             |                                                       | -               | - | - | -  | 5       |
| Total credits for Honours/Minor students:                                                                                                                 |          |             |                                                       | -               | - | - | -  | 26      |
| Summer/ Inter-sem Mandatory Bridge Courses : 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet) |          |             |                                                       | -               | - | - | -  | -       |

| Open Elective – II |             |                                                    |
|--------------------|-------------|----------------------------------------------------|
| S. No.             | Course Code | Course Title                                       |
| 1.                 | U24OE601A   | Management Economics and Accountancy               |
| 2.                 | U24OE601B   | Engineering Finance                                |
| 3.                 | U24OE601C   | Organizational Behaviour                           |
| 4.                 | U24OE601D   | E-Commerce and Digital Marketing                   |
| 5.                 | U24OE601Z   | Any other course approved by BoS Chair and Dean AA |

**Bridge Courses for exit:**

Successful completion of two subjects (6-Credits) during 2-months internship at the institute

OR

Successful completion of two suitable skill based courses (external) to qualify for Certification

**C. After Third Year: (B. Voc. in ECE)**

- (i) The candidate should pass any two of the following additional courses (Degree Level) during the 2-Months internship at institute

| Exit Option to Qualify <b>B. Voc in ECE: Any Two (02) Courses</b> during the 2 - Months internship |          |             |                                                    |   |   |   |   |   |   |
|----------------------------------------------------------------------------------------------------|----------|-------------|----------------------------------------------------|---|---|---|---|---|---|
| S. No.                                                                                             | Category | Course Code | Course Title                                       | L | T | P | O | E | C |
| 1                                                                                                  | PCC      | U24EC610X   | Low Power VLSI                                     | 2 | - | 2 | - | 4 | 3 |
| 2                                                                                                  | PCC      | U24EC611X   | 5G and beyond 5G communications                    | 2 | - | 2 | - | 4 | 3 |
| 3                                                                                                  | PCC      | U24EC612X   | Real-Time Operating Systems (RTOS)                 | 2 | - | 2 | - | 4 | 3 |
| 4                                                                                                  | PCC      | U24EC613X   | Any other course approved by BoS Chair and Dean AA | 2 | - | 2 | - | 4 | 3 |

(OR)

- (ii) Any two suitable skill based courses to qualify for B. Voc in ECE Degree.

| Exit Option to Qualify <b>B. Voc in ECE: Any Two (02) Skill based Courses -:</b> |          |             |                                                                                                                                                                                                                                                                                                                            |   |   |   |   |   |   |
|----------------------------------------------------------------------------------|----------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|
| S. No.                                                                           | Category | Course Code | Course Title                                                                                                                                                                                                                                                                                                               | L | T | P | O | E | C |
| 1                                                                                | SEC      | U24SE610X   | Internet of Things (IOT) using Arduino <a href="https://www.nitttrchd.ac.in/imee/Labmanuals/manual%20Internet%20of%20Things%20I.pdf">https://www.nitttrchd.ac.in/imee/Labmanuals/manual%20Internet%20of%20Things%20I.pdf</a>                                                                                               | - | - | 6 | - | 6 | 3 |
| 2                                                                                | SEC      | U24SE611X   | Embedded System Design using ARM/Cortex Micro Controller <a href="https://www.nielit.gov.in/aurangabad/content/certificate-course-embedded-system-design-using-arm-cortex-microcontroller-0">https://www.nielit.gov.in/aurangabad/content/certificate-course-embedded-system-design-using-arm-cortex-microcontroller-0</a> | - | - | 6 | - | 6 | 3 |
| 3                                                                                | SEC      | U24SE612X   | Embedded System using 8051 and Arduino <a href="https://www.nielit.gov.in/sites/default/files/PDF/Training/EmbeddedSystemusing8051andArduino.pdf">https://www.nielit.gov.in/sites/default/files/PDF/Training/EmbeddedSystemusing8051andArduino.pdf</a>                                                                     | - | - | 6 | - | 6 | 3 |
| 4                                                                                | SEC      | U24SE613X   | Any other skill-based course approved by BoS Chair and Dean AA                                                                                                                                                                                                                                                             | - | - | 6 | - | 6 | 3 |

(Note to HoDs on PCC: Under PCC the departments shall plan appropriate courses upto 6<sup>th</sup> semester covering GATE syllabus).

## MANAGEMENT ECONOMICS AND ACCOUNTANCY

|                                        |                  |                              |            |
|----------------------------------------|------------------|------------------------------|------------|
| <b>Class:</b> B. Tech. VI Semester     |                  | <b>Branch:</b> Common to all |            |
| <b>Course Code:</b>                    | <b>U24OE601A</b> | <b>Credits:</b>              | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>2-1-0-3</b>   | <b>CIE:</b>                  | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36 Hrs</b>    | <b>ESE:</b>                  | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

**CO1 :** comprehend the basic concepts of management, functions of management

**CO2 :** distinguish between micro & macroeconomics & forms of business organizations

**CO3 :** pass journal entries & post them into ledgers, prepare profit & loss accounts and assesses the financial position through the balance sheet

**CO4 :** evaluate financial statements with a the help of various ratios and reveal the financial health of the organization

### UNIT-I

**9 Hrs**

**Introduction to Management:** Concept of Management, Features of Management, Importance of Management, Nature and Scope of Management, Fayol's Administrative Management, Taylor's Scientific Management

**Functions of Management: Planning-** Concept of Planning, Nature of Planning, Importance of Planning, Planning Process, Types of Planning; **Organizing-** Concept of Organizing, Organization Structure- line and staff, Advantages of Organizing; **Staffing** - Meaning, Functions of Human Resources Management; **Directing-** Elements of Directing- Supervision; Leadership- Nature; Motivation - Nature, Types; Communication- Process, Types, Barriers to effective communication; **Co-ordination-** Definition, Steps to achieve effective coordination; **Controlling-** Definition, Process

### UNIT-II

**9 Hrs**

**Economics:** Meaning and definition, Scope, Micro and Macro Economics, Methods of Economics

**Forms of Business Organization:** Sole Proprietor ship, Partnership firm - Types of Partners, Limited Liability Partnership (LLP), Joint Stock Company - Features, Types, Merits and demerits, Cooperative society

### UNIT-III

**9 Hrs**

**Introduction to Financial Accounting:** Accounting concepts and conventions, Double Entry System and Book Keeping, Overview of accounting cycle, Journal-meaning, Journalizing, Ledger - Meaning, Ledger posting, Balancing; Cash book (Single column), Preparation of Trial balance

**Final Accounts:** Trading Account, profit and loss account and Balance Sheet with simple adjustments

#### UNIT-IV

9 Hrs

**Financial Statement Analysis:** Introduction to Financial Statement Analysis, Ratio Analysis, Introduction, Types of Ratios, Analysis and Interpretation of Liquidity Ratios, Profitability ratios, Activity Ratios, and Capital structure Ratios (simple problems)

#### TextBook(s):

4. L.M.Prasad, *Principles and Practices of Management*, Sultan Chand & Sons Educational Publishers, 11<sup>th</sup> edition.2025, New Delhi. (Part –I to Part-VI)
5. D. N. Dwivedi, *Engineering Economics: Text & Cases*, Vikas Publishing, 5th edition, 2014. (Chapter-3)
6. R. Narayana Swamy, *Financial Accounting – A Managerial Perspective*, Prentice Hall of India, 7<sup>th</sup> edition, 2023,newDelhi.( Chapter VI)

#### Reference Book(s):

1. Harold Koontz and Heinz Weihrich, *Essentials of Management*, 6th ed. New Delhi: Tata Mc Graw Hill Publications, 2015.
2. Maheshwari, S. N., & Maheshwari, S. K. (2024). *Financial Accounting* (7th ed.). Vikas Publishing House Pvt. Ltd, 2024.

#### Web and Video link(s):

[https://onlinecourses.nptel.ac.in/e-learning/preview/noc25\\_mg52](https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_mg52); NPTEL Video Lecture on *Principles of Management* by Prof. Usha Lenka, Professor of Management Studies department, IIT Roorkee.

[https://onlinecourses.nptel.ac.in/e-learning/preview/noc25\\_ec10](https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ec10); NPTEL Video Lecture on *Foundations of Accounting & Finance* by Prof. Arun Kumar Gopalaswamy, Professor of Management Studies department, IIT Madras.

| Course Articulation Matrix (CAM): |             |     |     |      | U24OE601A: MANAGEMENT ECONOMICS AND ACCOUNTANCY |     |      |     |      |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|------|-------------------------------------------------|-----|------|-----|------|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3  | PO4                                             | PO5 | PO6  | PO7 | PO8  | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24OE601A.1 | -   | 3   | 3    | 2                                               | -   | 2    | 2   | 3    | 3   | 3    | 3    | -    | 1    |
| CO2                               | U24OE601A.2 | -   | 2   | 2    | -                                               | -   | 2    | 3   | 3    | 3   | 3    | 3    | -    | 1    |
| CO3                               | U24OE601A.3 | -   | 1   | 2    | 1                                               | -   | 2    | 3   | 2    | 3   | 3    | 3    | -    | 1    |
| CO4                               | U24OE601A.4 | -   | 2   | 2    | 2                                               | -   | 1    | 2   | -    | 3   | 2    | 3    | -    | 1    |
| U24OE601A                         |             | -   | 2   | 2.25 | 1.67                                            | -   | 1.75 | 2.5 | 2.67 | 3   | 2.75 | 3    | -    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |      |                                                 |     |      |     |      |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                             |                 |                                  |                                                                                                                                                                                                                                 |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                     | Relevant<br>SDG | SDG<br>Description               | Mapping Justification                                                                                                                                                                                                           |
| CO1                     | comprehend the basic concepts of management                                                                                                 | SDG 4           | Quality Education                | Understanding the management concepts and managerial function will help the students to take effective and efficient decisions and able to solve work place problems.                                                           |
| CO2                     | distinguish between micro & macro-economics & forms of business organizations                                                               | SDG 8           | Decent Work and Economic Growth  | Economics concepts will help to promote sustained, inclusive and sustainable economic growth, and different forms of organizations will provide knowledge about creating full and productive employment and decent work for all |
| CO3                     | pass journal entries & post them into ledgers, prepare profit & loss accounts and assesses the financial position through the balance sheet | SDG 17          | Partnerships for the goals       | accounting concepts and conventions will promote a universal, rules-based, open, non-discriminatory and equitable application of                                                                                                |
| CO4                     | evaluate financial statements with a the help of various ratios and reveal the financial health of the organization                         | SDG 8           | Decent Work and Economic Growth. | Evaluating financial statements through ratio analysis reveals the financial health of an organization, enabling better decision-making, efficient resource utilization, and sustainable growth.                                |

| <b>ENGINEERING FINANCE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                              |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------|--------------|
| <b>Class:</b> B.Tech.VI-Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  | <b>Branch:</b> Common to all |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>U24OE601B</b> | <b>Credits:</b>              | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>2-1-0-3</b>   | <b>CIE:</b>                  | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>36 Hrs</b>    | <b>ESE:</b>                  | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |                              |              |
| <b>CO1:</b> explain fundamentals of engineering finance, financial management objectives, ethics, and time value of money concept.<br><b>CO2 :</b> apply capital budgeting techniques including inflation adjusted Net Present Value/Internal Rate Return for project evaluation and selection.<br><b>CO3:</b> analyse various cost concepts and determine breakeven point for make or buy decisions in engineering projects.<br><b>CO4:</b> evaluate asset replacement decisions and apply depreciation methods to determine the economic life and value of engineering assets. |                  |                              |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                              | <b>9 Hrs</b> |
| <b>Fundamentals of Engineering Finance</b><br>Engineering Finance - Meaning, Definition, and Scope; Role of Finance in Engineering - Importance for engineers in decision making and cost control; Ethics in Engineering Finance - Transparency, Cost estimation honesty, Avoidance of financial conflicts of interest; Financial Management - Meaning, Functions, Objectives (profit maximization v/s. wealth maximization), Sources of Finance, Time value of Money                                                                                                            |                  |                              |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                              | <b>9 Hrs</b> |
| <b>Investment Decisions</b><br>Investment Decisions- Types of Investment projects, Investment evaluation criteria; Methods of capital budgeting - Discounted cash flow techniques v/s. non discounted cash flow techniques, Inflation adjusted NPV and IRR, Comparison and selection of mutually exclusive engineering projects                                                                                                                                                                                                                                                  |                  |                              |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |                              | <b>9 Hrs</b> |
| <b>Cost-Volume-Profit Analysis</b><br>Cost concepts- Fixed, Variable, Marginal, Sunk, Opportunity costs, Direct and Indirect costs; Breakeven analysis - Meaning, Assumptions, Graphical and Mathematical determination of breakeven point; Make or buy decisions using breakeven analysis; Application of breakeven analysis in engineering projects                                                                                                                                                                                                                            |                  |                              |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                              | <b>9 Hrs</b> |
| <b>Replacement Decisions and Valuation of engineering assets</b><br>Replacement analysis - Meaning, Need, Defender v/s. Challenger concept; Economic service life; Valuation of equipment's and physical assets - Depreciation definition, Depreciation fund; Methods of depreciation - straight line, Declining balance, Sum of the years-digits, Sinking fund and Service output method, Application of depreciation methods on equipment's and physical asset with the passage of time.                                                                                       |                  |                              |              |
| <b>TextBook(s):</b><br>1. M Y Khan and P K Jain, <i>Financial Management</i> , Tata McGraw Hill 5 <sup>th</sup> edition, ISBN:978-0-07-065614-7 (Unit-I in part 1 of section 1,2&3 and Unit-II in part 3 of 9&10).                                                                                                                                                                                                                                                                                                                                                               |                  |                              |              |

2. R. Panneerselvam, *Engineering Economics*, PHI Learning 2<sup>nd</sup> edition, ISBN:978-81-203-4837-0(Unit-III in Chapter 1&16 and Unit-IV in Chapter 8& 9).

**Reference Book(s):**

1. F.K. Crundwell, *Finance for Engineers: Evaluation and Funding of Capital Projects*, Springer London Ltd, Atlantic Publishers and Distributors (P) Ltd., ISBN: 978-1849967082, 2010.
2. Robert L. Kosowski, Salih N. Neftci, *Principles of financial engineering*, Academic press, Atlantic Publishers and Distributors (P) Ltd. 3<sup>rd</sup> edition, ISBN: 978-0123869685, 2014.
3. D. N. Dwivedi, *Engineering Economics: Text & Cases*, Vikas Publishing, 5<sup>th</sup> edition, ISBN: 9788126510887, 2014.
4. Prasanna Chandhra, *Financial Management: Theory and Practice*, TataMc GrawHillEducation (India) private limited, ISBN-10: 93-392-1225-8, 2015.
5. Chan S. Park, *Fundamentals of Engineering Economics*, Pearson Education. 3<sup>rd</sup> edition, ISBN: 978-9352864379, 2017.
6. Chatterjee Partha Sheikh Salim, *Engineering Economy & Financial Management*, Himalaya Publishing House, ISBN:978-9350247389, 2011.

| Course Articulation Matrix(CAM): |             |     |     |     |     |     | U24OE601B:ENGINEERING FINANCE |     |     |      |      |      |      |
|----------------------------------|-------------|-----|-----|-----|-----|-----|-------------------------------|-----|-----|------|------|------|------|
| CO                               | PO 1        | PO2 | PO3 | PO4 | PO5 | PO6 | PO7                           | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                              | U24OE601B.1 | 2   | -   | -   | -   | -   | 2                             | -   | -   | 2    | 2    | -    | 1    |
| CO2                              | U24OE601B.2 | -   | 3   | -   | -   | 2   | -                             | -   | -   | -    | 3    | -    | 1    |
| CO3                              | U24OE601B.3 | -   | -   | 2   | -   | -   | -                             | 2   | -   | 2    | -    | -    | 1    |
| CO4                              | U24OE601B.4 | -   | -   | 2   | 2   | -   | 2                             | -   | -   | 2    | 2    | -    | 1    |
| U24OE601B                        |             | 2   | 3   | 2   | 2   | 2   | 2                             | 2   | -   | 2    | 2,3  | -    | 1    |
| 3-HIGH,2-MEDIUM,1-LOW            |             |     |     |     |     |     |                               |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                        |                        |                                                                             |                                                                                                                                                                |
|-------------------------|------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                | Relevant SDG           | SDG Description                                                             | Mapping Justification                                                                                                                                          |
| CO1                     | Explain fundamentals of engineering finance, financial management objectives, ethics, and time value of money concept. | SDG 4<br>And<br>SDG 16 | Quality Education and Peace, Justice and Strong Institutions                | Promotes financial literacy, ethical decision-making, and professional responsibility essential for quality education and transparent institutional practices. |
| CO2                     | Apply capital budgeting techniques including inflation adjusted NPV/IRR for project evaluation and selection.          | SDG 8<br>And<br>SDG 9  | Decent Work and Economic Growth And Industry, Innovation and Infrastructure | Supports economically viable investment decisions, efficient resource allocation, industrial growth, and sustainable infrastructure development.               |
| CO3                     | Analyse various cost concepts and determine breakeven                                                                  | SDG 9<br>And           | Industry, Innovation and                                                    | Encourages cost efficiency, optimized production planning,                                                                                                     |

| CO-SDG Alignment Matrix |                                                                                                                                     |                        |                                                                            |                                                                                                                                   |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                             | Relevant<br>SDG        | SDG Description                                                            | Mapping Justification                                                                                                             |
|                         | point for make or buy decisions in engineering projects.                                                                            | SDG 12                 | Infrastructure and Responsible Consumption and Production                  | and responsible utilization of resources in engineering and industrial projects                                                   |
| CO4                     | Evaluate asset replacement decisions and apply depreciation methods to determine the economic life and value of engineering assets. | SDG 8<br>And<br>SDG 12 | Decent Work and Economic Growth and Responsible Consumption and Production | Promotes sustainable asset management, economic efficiency, lifecycle optimization, and responsible use of engineering resources. |

| ORGANIZATIONAL BEHAVIOUR                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                       |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------|--------------|
| Class: B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           | Branch: Common to all |              |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | U26OE601C | Credits:              | 3            |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 2-1-0-3   | CIE:                  | 60%          |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 36Hrs     | ESE:                  | 40%          |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                          |           |                       |              |
| <b>CO1 :</b> evaluate the fundamentals, importance, influencing factors, and communication processes of Organizational Behaviour.                                                                                                                                                                                                                                                                                                                                                         |           |                       |              |
| <b>CO2 :</b> analyse individual behaviour including personality, perception, learning, attitudes, emotions, stress, and motivation.                                                                                                                                                                                                                                                                                                                                                       |           |                       |              |
| <b>CO3 :</b> examine group behaviour, team effectiveness, conflict management, leadership, power, politics, and group dynamics in organizational settings.                                                                                                                                                                                                                                                                                                                                |           |                       |              |
| <b>CO4 :</b> evaluate organizational structure, culture, innovation, change, organizational effectiveness, quality of work life, and international organizational behaviour.                                                                                                                                                                                                                                                                                                              |           |                       |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                       | <b>9 Hrs</b> |
| <b>Introduction:</b> Foundations of organizational behavior, Concept, Importance, Factors influencing organizational behavior, Challenges and opportunities for organization behavior; Managerial perspective of OB; Communication-Process-channels-communication barriers , Measures to overcome barriers                                                                                                                                                                                |           |                       |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                       | <b>9 Hrs</b> |
| <b>Individual Behavior:</b> Individual in the organization, Nature of man, Models of man, Personality-Stages of development of personality; Perception-Factors influencing perception; Learning-Theories of Learning-Cognitive Learning Theory, Behaviourist Learning Theory; Attitudes-Formation of attitudes; Personality and emotions, Managing emotions and stress in organizations; Motivation- Motivation theories-Maslow's Needs Hierarchy Theory and Herzberg's Two-Factor Theory |           |                       |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                       | <b>9 Hrs</b> |
| <b>Group decision making:</b> Groups in organization, Basic group concepts, Groups vs. Teams, Understanding work teams-Types of teams, Creating effective teams; Conflicts-Types of conflicts, Strategies for resolution of conflicts in groups<br><br><b>Group dynamics:</b> Group dynamics, Leadership-Leadership types and managerial effectiveness, Trust and leadership, Power and politics, Basis of power, Organizational politics                                                 |           |                       |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                       | <b>9 Hrs</b> |
| <b>Organization structure:</b> Organization structure, Size and design; Organizational culture; Organizational change-Resistance to change; Organizational stress- Factors contribute to                                                                                                                                                                                                                                                                                                  |           |                       |              |

stress, Coping strategies, Stress and performance; Organizational effectiveness-concepts; Quality of work life-concepts; International organizational behavior-concepts

**TextBook(s):**

1. Stephen P. Robbins, Timothy A. Judge & Neharika Vohra, *Organizational Behavior*, Pearson India, 18th edition, 2022, New Delhi. (Chapter I to IV)
2. K. Aswathappa, *Organizational Behaviour*, Himalaya Publishing House, 14th edition, 2021, Mumbai. (Chapter I to IV)

**Reference Book(s):**

1. Fred Luthans, *Organizational Behavior*, McGraw Hill Education, 13th edition, 2020, New York.
2. Uma Sekaran, *Organizational Behavior: Text and Cases*, McGraw Hill Education, 2nd edition, 2019, New Delhi.
3. S. S. Khanka, *Organizational Behavior*, S. Chand Publishing, 11th edition, 2021, New Delhi..

**Web and Video link(s):**

1. Harvard Business Review – Organizational Behavior Articles and Videos ;*Web resources and expert videos on leadership, teamwork, communication, conflict management, and organizational effectiveness.*

| Course Articulation Matrix (CAM): |             |     |     | U26OE601C: ORGANIZATIONAL BEHAVIOUR |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|-------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                                 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U26OE601C.1 | 2   | -   | -                                   | -   | -   | -   | -   | 2   | 2   | -    | -    | -    | -    |
| CO2                               | U26OE601C.2 | -   | 3   | -                                   | -   | -   | -   | 2   | --  | -   | -    | 3    | -    | -    |
| CO3                               | U26OE601C.3 | -   | 2   | -                                   | -   | -   | -   | -   | 2   | 2   | 2    | -    | -    | -    |
| CO4                               | U26OE601C.4 | -   | -   | 2                                   | -   | -   | 2   | -   | -   | -   | 2    | 2    | -    | -    |
| U26OE601C                         |             | 2   | 2.5 | 2                                   | -   | -   | 2   | 2   | 2   | 2   | 2    | 2.5  | -    | -    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                     |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                     |                 |                    |                                                                                                                                                                 |
|-------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                             | Relevant<br>SDG | SDG<br>Description | Mapping Justification                                                                                                                                           |
| CO1                     | Explain the fundamentals, importance, influencing factors, and communication processes of Organizational Behaviour. | SDG 4           | Quality Education  | Understanding organizational behaviour and communication processes helps students develop professional knowledge, communication, and workplace learning skills. |
| CO2                     | Analyse individual                                                                                                  | SDG 3           | Good Health        | Analysing emotions, stress,                                                                                                                                     |

| CO-SDG Alignment Matrix |                                                                                                                                                                 |                 |                                        |                                                                                                                                                                  |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                         | Relevant<br>SDG | SDG<br>Description                     | Mapping Justification                                                                                                                                            |
|                         | behaviour including personality, perception, learning, attitudes, emotions, stress, and motivation.                                                             |                 | and Well-being                         | motivation, and attitudes promotes mental well-being, self-management, and healthy work practices.                                                               |
| CO3                     | Examine group behaviour, team effectiveness, conflict management, leadership, power, politics, and group dynamics in organizational settings.                   | SDG 16          | Peace, Justice and Strong Institutions | Studying leadership, conflict management, teamwork, and group dynamics supports inclusive, cooperative, and effective organizational practices                   |
| CO4                     | Evaluate organizational structure, culture, innovation, change, organizational effectiveness, quality of work life, and international organizational behaviour. | SDG 8           | Decent Work and Economic Growth        | Evaluating organizational culture, innovation, quality of work life, and change management supports productive employment and sustainable organizational growth. |

| <b>E-COMMERCE &amp; DIGITAL MARKETING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |                              |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------|--------------|
| <b>Class:</b> B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  | <b>Branch:</b> Common to all |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>U24OE601D</b> | <b>Credits:</b>              | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>2-1-0-3</b>   | <b>CIE:</b>                  | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>36 Hrs</b>    | <b>ESE:</b>                  | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |                              |              |
| <b>CO1 :</b> interpret the concepts, scope, types, functions, framework, opportunities, and limitations of E-Commerce, and analyse its role in modern business and electronic transactions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                              |              |
| <b>CO2 :</b> analyze e-payment systems, e-finance operations, e-banking, e-trading, and the legal framework governing e-commerce transactions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                              |              |
| <b>CO3 :</b> evaluate digital marketing practices, emerging trends, and consumer behaviour in the online environment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                  |                              |              |
| <b>CO4 :</b> determine digital marketing channels and design effective online marketing plans                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                              |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                              | <b>9 Hrs</b> |
| <b>Introduction to E-Commerce:</b> E-Commerce – Introduction, Definition, Scope, Evolution, Internet Commerce vs E-Commerce; Electronic Commerce Market; E-Commerce Industry Framework; Trade Cycle in E-Commerce; Electronic Data Interchange (EDI); E-Commerce Functions; Types of E-Commerce – B2B, B2C, C2C, C2B, B2G, G2B, and G2C; Forces fuelling E-Commerce – Differences between Traditional Commerce and E-Commerce; Limitations of E-Commerce; Introduction to Artificial Intelligence (AI) in E-Commerce                                                                                                                                                                                                    |                  |                              |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |                              | <b>9 Hrs</b> |
| <b>E-payment Systems:</b> Digital payment Requirements; Types of E-Payment Systems - Digital Token-based E-payment systems, Credit card as E-payment system, Mobile payments, smart card cash payment system, Micropayment system, E-Security, E- Cash; E-Finance: Areas of Financing; E-Banking - Traditional Banking Vs. E-Banking; Operations in E-Banking; E-Trading – Stock Market trading; Importance and advantages of E-Trading<br><b>Legal Framework for E-Commerce:</b> E-Commerce Legal Framework - The Information Technology Act 2000, Information Technology (Amendment) Act, 2008, Copyrights, Defamation, Privacy, Contracts, Taxation, Signing a contract Electronically, Domain name and Registration |                  |                              |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                              | <b>9 Hrs</b> |
| <b>Digital Marketing:</b> Concept, Components of Digital Marketing, Need and Scope of Digital Marketing, Benefits of Digital Marketing, Digital Marketing Platforms and Strategies, Comparison of Marketing and Digital Marketing, Digital Marketing Trends, Marketing in the Digital Era: Segmentation – Importance of Audience Segmentation, different segments used in Digital Media – Organizational characteristics, purchasing characteristics, using Digital Media to Reach, acquisition and retention of new customers, Digital Media for Customer Loyalty                                                                                                                                                      |                  |                              |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |                              | <b>9 Hrs</b> |

**Channels of Digital Marketing:**Digital Marketing, Website Marketing, Search Engine Marketing, Search Engine optimization, Online Advertising, Email Marketing-Campaign Design, Automation, Personalization, Blog Marketing-Content Creation, Blogging Platforms, Social Media Marketing-Marketing through Facebook, Instagram, LinkedIn, X (Twitter), and youtube, Audio, Video and Interactive Marketing, Mobile Marketing; Digital Marketing Plan: Need for Digital Marketing Plan, Elements of Digital Marketing Plan, Writing the Marketing Plan and Implementation

**TextBook(s):**

1. C. S. V. Murthy- *E-Commerce: Concepts, Models & Strategies*, Himalaya Publishing House 2nd Edition (2025).
2. Seema Gupta – *Digital Marketing*, McGraw-Hill 3rd Edition, 2022/ 2023.
3. Tracy L. Tuten & Michael R. Solomon – *Social Media Marketing*, SAGE Publication, 5th Edition, 2023.

**Reference Book(s):**

1. Matthew Reynolds – *Beginning E-Commerce with Visual Basic, ASP, SQL Server 7.0 & MTS*, published by Wrox Publisher.
2. P. T. Joseph, S.J. *E-Commerce: An Indian Perspective, Latest Edition: 7th Edition (2023)* Publisher: PHI Learning Pvt. Ltd.
3. Michael Miller – *B2B Digital Marketing: Using the Web to Market Directly to Businesses* 1st Edition (2012; Indian reprint 2014/2015) Pearson India / Que Publishing.

**Web and Video link(s):**

1. <https://youtu.be/qnBhOVH1QQ8?si=6UtzpR5d6t8Rk5da>Digital Marketing Full Course 2026 In 24 Hrs | Digital Marketing Tutorial For Beginners
2. [https://youtu.be/qsO\\_YCjgBFI?si=zVdKwrU8l6eEr4wg](https://youtu.be/qsO_YCjgBFI?si=zVdKwrU8l6eEr4wg)

| Course Articulation Matrix (CAM): |             |     |     | U24OE601D:E-COMMERCE & DIGITAL MARKETING |     |     |      |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|------------------------------------------|-----|-----|------|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1 | PO2 | PO3                                      | PO4 | PO5 | PO6  | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24OE601D.1 | 2   | 2   | 1                                        |     | 2   | 1    | -   | -   | 1   |      | 2    | -    | 1    |
| CO2                               | U24OE601D.2 | 2   | 2   | 1                                        | 1   | 2   | 2    | 1   | -   | 1   | 1    | 1    | -    | 1    |
| CO3                               | U24OE601D.3 | 2   | 2   | 2                                        | 1   | 2   | 1    | 1   | 1   | 2   | 1    | 2    | -    | 1    |
| CO4                               | U24OE601D.4 | 2   | 2   | 2                                        | 2   | 2   | 1    | 1   | 2   | 2   | 2    | 2    | -    | 1    |
| U24OE601D                         |             | 2   | 2   | 1.5                                      | 1.3 | 2   | 1.25 | 1   | 1.5 | 1.5 | 1.3  | 1.75 | -    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                          |     |     |      |     |     |     |      |      |      |      |

| <b>CO-SDG Alignment Matrix</b> |                                                                                                                                                                                 |                         |                                         |                                                                                                                                           |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO</b>                      | <b>CO Statement</b><br><i>The student should be able to...</i>                                                                                                                  | <b>Relevant<br/>SDG</b> | <b>SDG Description</b>                  | <b>Mapping Justification</b>                                                                                                              |
| CO1                            | Understand the concepts, scope, types, functions, framework, opportunities, and limitations of E-Commerce, and analyse its role in modern business and electronic transactions. | <b>SDG 8</b>            | Decent Work and Economic Growth         | E-Commerce promotes entrepreneurship, digital business growth, employment opportunities, and innovation in the global economy             |
| CO2                            | Analyse e-payment systems, e-finance operations, e-banking, e-trading, and the legal framework governing e-commerce transactions.                                               | <b>SDG 9</b>            | Industry, Innovation and Infrastructure | Digital payment systems and e-banking strengthen technological infrastructure, financial inclusion, and innovation in digital industries. |
| CO3                            | Evaluate digital marketing practices, emerging trends, and consumer behaviour in the online environment.                                                                        | <b>SDG 12</b>           | Responsible Consumption and Production  | Digital marketing helps organizations understand consumer behaviour and promote sustainable and responsible consumption patterns.         |
| CO4                            | Analyse digital marketing channels and design effective online marketing plans.                                                                                                 | <b>SDG 17</b>           | Partnerships for the Goals              | Digital marketing channels improve global communication, collaboration, networking, and partnerships among businesses and stakeholders    |

| <b>DESIGN FOR TESTABILITY</b>                                                                                                                                                                                                                                                                                                                                   |                  |                    |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                            |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                             | <b>U24EC602A</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                    | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                          | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                |                  |                    |              |
| <b>CO1:</b> Explain testing fundamentals and fault simulation techniques.<br><b>CO2:</b> Analyze and sequential testing methodologies.<br><b>CO3:</b> Design scan-based and BIST-enabled architectures.<br><b>CO4:</b> Apply advanced DFT techniques for modern IC systems.                                                                                     |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                   |                  |                    | <b>9 Hrs</b> |
| <b>BASICS OF TESTING AND FAULT MODELING:</b> Introduction to VLSI testing, need for testing, principles of testing, manufacturing defects and failures, types of testing, DC parametric testing, AC parametric testing, fault models, stuck-at fault model, fault equivalence, fault collapsing, fault dominance, fault simulation techniques and applications. |                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                  |                  |                    | <b>9 Hrs</b> |
| <b>TESTING OF COMBINATIONAL AND SEQUENTIAL CIRCUITS:</b> Test generation basics, path sensitization, Boolean difference method, D-algorithm, PODEM algorithm, testing of sequential circuits as iterative combinational circuits, state table verification, scan path design, partial scan, boundary scan testing.                                              |                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                 |                  |                    | <b>9 Hrs</b> |
| <b>MEMORY TESTING, DELAY FAULTS AND IDDQ TESTING:</b> Testable memory design, RAM fault models, march test algorithms, delay faults, transition faults, path delay faults, delay testing methods, IDDQ testing principles, IDDQ testing techniques, advantages and limitations of IDDQ testing.                                                                 |                  |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                  |                  |                    | <b>9 Hrs</b> |
| <b>BUILT-IN SELF-TEST (BIST) AND ADVANCED DFT TECHNIQUES:</b> Introduction to BIST, test pattern generation, linear feedback shift registers (LFSR), output response analysis, signature analysis, BIST architectures, self-checking circuits, embedded core testing, system-on-chip testing methodologies and applications.                                    |                  |                    |              |
| <b>TextBook(s):</b><br>1.M. Abramovici, M. A. Breuer and A. D. Friedman, <i>Digital Systems Testing and Testable Design</i> , Jaico Publishing House.<br>2. P. K. Lala, <i>Digital Circuit Testing and Testability</i> , Academic Press.                                                                                                                        |                  |                    |              |
| <b>Reference Book(s):</b><br>1. Bushnell and Agrawal, <i>Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits</i> , Springer.<br>2. N. K. Jha and S. Gupta, <i>Testing of Digital Systems</i> , Cambridge University Press.                                                                                                      |                  |                    |              |

3. Alfred L. Crouch, *Design for Test for Digital ICs and Embedded Core Systems*, Prentice Hall.
4. ZainalabedinNavabi, *Digital System Test and Testable Design*, McGraw-Hill.
5. Vishwani D. Agrawal, *Essentials of Electronic Testing*, Springer.

**Web and Video link(s):**

1. <https://www.onlinecourses.nptel.ac.in>; NPTEL Video Lecture on Digital VLSI Testing by Prof. Santanu Chattopadhyay, Professor of E&ECE department, IIT Kharagpur.

| Course Articulation Matrix (CAM): |             |     |      | U24EC602A: DESIGN FOR TESTABILITY |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|------|-----------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1 | PO2  | PO3                               | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC602A.1 | 3   | 2    | -                                 | 1    | -    | -   | 1   | -   | -   | -    | -    | 1    | 2    |
| CO2                               | U24EC602A.2 | 3   | 3    | 2                                 | 2    | 1    | -   | 1   | -   | -   | -    | -    | 1    | 2    |
| CO3                               | U24EC602A.3 | 3   | 3    | 2                                 | 2    | 1    | -   | 1   | -   | -   | -    | -    | 1    | 2    |
| CO4                               | U24EC602A.4 | 3   | 3    | 3                                 | 2    | 2    | -   | 1   | -   | -   | -    | -    | 2    | 2    |
| U24EC602A                         |             | 3   | 2.75 | 2.33                              | 1.75 | 1.33 | -   | 1   | -   | -   | -    | -    | 1.25 | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |      |                                   |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                  |                 |                                         |                                                                                                   |
|-------------------------|----------------------------------------------------------------------------------|-----------------|-----------------------------------------|---------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                          | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                             |
| CO1                     | Analyze testing fundamentals and fault simulation techniques                     | SDG 4           | Quality Education                       | Enhances technical knowledge and advanced VLSI testing skills.                                    |
| CO2                     | Apply ATPG algorithms and scan-based testing methodologies for digital circuits. | SDG 8           | Decent Work and Economic Growth         | Supports semiconductor industry skill development and employability.                              |
| CO3                     | Design testable VLSI systems using DFT and BIST techniques.                      | SDG 9           | Industry, Innovation and Infrastructure | Encourages innovation in reliable electronic system design and testing.                           |
| CO4                     | Analyze memory testing and SoC testing methodologies.                            | SDG 12:         | Responsible Consumption and Production  | Improves product reliability and reduces electronic waste through efficient testing methodologies |

| DATA COMMUNICATIONS AND COMPUTER NETWORKS                                                                                                                                                                                                                                                                                                                                                     |           |             |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                 |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                  | U24EC602B | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                         | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                               | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                              |           |             |       |
| CO1 : Explain fundamental concepts of data communication and layered architectures.                                                                                                                                                                                                                                                                                                           |           |             |       |
| CO2 : Apply switching and routing techniques for efficient internetworking                                                                                                                                                                                                                                                                                                                    |           |             |       |
| CO3 : Demonstrate transport and application layer protocols through practical implementations                                                                                                                                                                                                                                                                                                 |           |             |       |
| CO4 : Analyze emerging networking technologies and their societal impact                                                                                                                                                                                                                                                                                                                      |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                        |           |             | 9 Hrs |
| <b>Fundamentals of Data Communication:</b> Analog and digital signals, bandwidth, data rate, transmission impairments, Transmission media: guided (twisted pair, coaxial, fibre optics) and unguided (wireless), Encoding and modulation techniques (ASK, FSK, PSK). Error detection (parity, CRC) and correction (Hamming codes). OSI and TCP/IP reference models – functions of each layer. |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                       |           |             | 9 Hrs |
| <b>Switching and Internetworking:</b> Switching techniques: circuit, packet, and message switching. Routing algorithms: shortest path, distance vector, link state, Congestion control methods. Internetworking devices: hubs, switches, routers, gateways. IP addressing, subnetting, and routing protocols (RIP, OSPF, BGP).                                                                |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                      |           |             | 9 Hrs |
| <b>Transport and Application Layer Protocols:</b> Transport layer services: connection-oriented vs. connectionless. TCP/UDP protocols, flow control, error control, congestion control. Socket programming basics (client-server model). Application protocols: HTTP, FTP, SMTP, DNS. Hands-on lab: building a simple chat application using sockets.                                         |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                       |           |             | 9 Hrs |
| <b>Emerging Trends in Computer Networks:</b> Wireless LANs, mobile networks (3G, 4G, 5G). Network security basics: cryptography, authentication, firewalls, VPNs.Cloud computing architectures and services. Internet of Things (IoT) networking protocols. Case study: Smart city applications using IoT.                                                                                    |           |             |       |
| <b><u>TextBook(s):</u></b><br><br>1. Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill.<br>2. Andrew S. Tanenbaum, Computer Networks, Pearson.                                                                                                                                                                                                                             |           |             |       |
| <b><u>Reference Book(s):</u></b><br><br>1. William Stallings, Data and Computer Communications, Pearson.<br>2. James F. Kurose & Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson                                                                                                                                                                                             |           |             |       |

| Course Articulation Matrix (CAM): |             |     | U24EC602B:DATA COMMUNICATIONS AND COMPUTER NETWORKS |      |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----------------------------------------------------|------|------|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2                                                 | PO3  | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC602B.1 | 3   | 2                                                   | 1    | 1    | 2    | 1   | -   | -   | -   | -    | -    | 2    | 2    |
| CO2                               | U24EC602B.2 | 2   | 3                                                   | 2    | 2    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC602B.3 | 2   | 2                                                   | 3    | 2    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC602B.4 | 1   | 2                                                   | 2    | 3    | 3    | 3   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC602B                         |             | 2   | 2                                                   | 2.25 | 2.25 | 2.75 | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |                                                     |      |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                    |                 |                                      |                                                                 |
|-------------------------|------------------------------------------------------------------------------------|-----------------|--------------------------------------|-----------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                            | Relevant<br>SDG | SDG<br>Description                   | Mapping Justification                                           |
| CO1                     | Explain the fundamentals of embedded systems, their components, and applications.  | SDG4            | Quality Education                    | Provides foundational knowledge in communication systems.       |
| CO2                     | Apply hardware–software co-design principles to develop embedded applications.     | SDG9            | Industry, Innovation, Infrastructure | Routing and switching support resilient digital infrastructure. |
| CO3                     | Demonstrate real-time operating system concepts through practical implementations. | SDG8            | Decent Work & Economic Growth        | Protocol skills enhance employability in IT industries.         |
| CO4                     | Analyze advanced embedded technologies and their societal impact.                  | SDG 11          | Sustainable Cities, Climate Action   | IoT and cloud enable smart cities and sustainable solutions.    |

| <b>BIO MEDICAL SIGNAL PROCESSING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                    |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>U24EC602C</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |                    |              |
| <b>CO1 :</b> learn the fundamental concepts of signal processing<br><b>CO2 :</b> apply common signal processing techniques for various biomedical signals<br><b>CO3 :</b> Understand electromyography signal processing and feature extraction<br><b>CO4 :</b> analyze polyphasic, Electrooculogram and Electroretinogram signals                                                                                                                                                                                                              |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |                    | <b>9 Hrs</b> |
| <b>Introduction to Biosignals:</b> Electrical activities of the Cell, Action Potential, Nature of Biomedical Signals, Examples of Biosignals, Objectives and difficulties in Biosignal processing and analysis.<br><br><b>Cardiac signal processing:</b> Electrocardiogram: Origin of ECG, ECG Electrode Placement, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Role of ECG in diagnosis of Cardiovascular Diseases, Denoising, Processing and Feature Extraction of ECG (Case Study) |                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |                    | <b>9 Hrs</b> |
| <b>Neural signal processing:</b> Electrophysiological origin of brain waves, EEG signal and its characteristics (EEG rhythms, waves, and transients), Evoked Potentials, Role of EEG in diagnosis of Central Nervous System disorders, Denoising, Processing and Feature Extraction of EEG (Case Study), Time- Domain Analysis, Frequency- Domain Analysis, Correlation Analysis of EEG Signal, Wavelet-Domain Analysis, Classification (Case study).                                                                                          |                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  |                    | <b>9 Hrs</b> |
| <b>Myo-signal processing:</b> Electromyogram- Signal of Muscles, Significance of EMG, Neuromuscular Diseases and EMG, Denoising, Processing and Feature Extraction of EMG (Case Study) – Time, Frequency and Time-Frequency analysis                                                                                                                                                                                                                                                                                                           |                  |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                  |                    | <b>9 Hrs</b> |
| <b>Introduction to other biosignals:</b> Blood Pressure and Blood Flow analysis, Photoplethysmogram signal processing and analysis, Electrooculogram and Electroretinogram signal analysis, Magnetoencephalogram, Respiratory Signals.                                                                                                                                                                                                                                                                                                         |                  |                    |              |
| <b><u>TextBook(s):</u></b><br><br>1. Kayvan Najarian and Robert Splinter, "Biomedical Signal and Image Processing", Second Edition, CRC Press, 2005. ( <i>Chapters 1,2,3, 8 to 11</i> )                                                                                                                                                                                                                                                                                                                                                        |                  |                    |              |

**Reference Book(s):**

1. R M Rangayyan “Biomedical Signal Analysis: A case Based Approach”, IEEE Press, John Wiley & Sons. Inc, 2002.
2. Willis J. Tompkins “Biomedical Digital Signal Processing”, IEEE, PHI, 2004.

**Web and Video link(s):**

ps://onlinecourses.nptel.ac.in/e-learning/preview/noc20\_ee41; NPTEL Video Lecture on Biomedical Signal Processing by Prof. By Prof. Sudipta Mukhopadhyay, IIT Kharagpur.

| Course Articulation Matrix (CAM): |             |     |     | U24EC602C: BIOMEDICAL SIGNAL PROCESSING |      |     |      |     |      |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|-----------------------------------------|------|-----|------|-----|------|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                                     | PO4  | PO5 | PO6  | PO7 | PO8  | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC602C.1 | 3   | 1   | -                                       | -    | 1   | 2    | -   | 1    | -   | -    | -    | 2    | 2    |
| CO2                               | U24EC602C.2 | 3   | 3   | 2                                       | 1    | 2   | 2    | -   | -    | 1   | -    | -    | 2    | 2    |
| CO3                               | U24EC602C.3 | 2   | 3   | 2                                       | 3    | 2   | 2    | 1   | 2    | -   | 1    | -    | 2    | 2    |
| CO4                               | U24EC602C.4 | 2   | 3   | 3                                       | 3    | 3   | 3    | 2   | 2    | 1   | 1    | 1    | 2    | 2    |
| U24EC602C                         |             | 2.5 | 2.5 | 2.33                                    | 2.33 | 2   | 2.25 | 1.5 | 1.66 | 1   | 1    | 1    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                         |      |     |      |     |      |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                              |                 |                                       |                                                                                      |
|-------------------------|------------------------------------------------------------------------------|-----------------|---------------------------------------|--------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                      | Relevant<br>SDG | SDG<br>Description                    | Mapping Justification                                                                |
| CO1                     | learn the fundamental concepts of signal processing                          | SDG3            | Good Health and Well-being            | Understanding biomedical signals like ECG supports healthcare technology development |
| CO2                     | apply common signal processing techniques for various biomedical signals     | SDG3            | Good Health and Well-being            | EEG analysis helps in early diagnosis of cardiac diseases                            |
| CO3                     | Understand electromyography signal processing and feature extraction         | SDG9            | Industry, Innovation & Infrastructure | Feature extraction contributes to innovation in medical devices                      |
| CO4                     | analyze polyplethismographic, Electrooculogram and Electroretinogram signals | SDG3            | Good Health and Well-being            | Different bio signals aids in analyzing blood pressure, blood flow and respiration   |

| EMBEDDED SYSTEM DESIGN                                                                                                                                                                                                                                                                                                                                                         |           |             |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                  |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                   | U24EC602D | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                          | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                               |           |             |       |
| <b>CO1:</b> Explain the fundamentals of embedded systems, their components, and applications.<br><b>CO2:</b> Apply hardware–software co-design principles to develop embedded applications.<br><b>CO3:</b> Demonstrate real-time operating system concepts through practical implementations.<br><b>CO4:</b> Analyze advanced embedded technologies and their societal impact. |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                         |           |             | 9 Hrs |
| <b>Introduction to Embedded Systems:</b> Definition, characteristics, and applications of embedded systems. Embedded hardware components: Processors, Memory, I/O devices. Embedded software: Firmware, device drivers. Design metrics: Performance, power, cost, reliability. Case studies: Consumer electronics, automotive systems.                                         |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                        |           |             | 9 Hrs |
| <b>Hardware–Software Co-Design:</b> Microcontrollers and microprocessors in embedded systems. Interfacing techniques: sensors, actuators, ADC/DAC. Communication protocols: I2C, SPI, UART, CAN. Embedded C programming basics. Interfacing LEDs, motors, and sensors with microcontrollers.                                                                                   |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                       |           |             | 9 Hrs |
| <b>Real-Time Operating Systems:</b> Concepts of real-time systems, Task scheduling, synchronization, and inter-process communication. RTOS architecture and services. Case study: Free RTOS programming, task creation, scheduling, and synchronization using RTOS.                                                                                                            |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                        |           |             | 9 Hrs |
| <b>Advanced Embedded Technologies:</b> Embedded networking: IoT protocols (MQTT, CoAP). Embedded security: cryptography, secure boot, trusted execution. Low-power design and energy-efficient systems. Applications in healthcare, smart cities, and industry automation. IoT-based sustainable solutions.                                                                    |           |             |       |
| <b>TextBook(s):</b> <ol style="list-style-type: none"> <li>1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw Hill.</li> <li>2. Frank Vahid &amp; Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley.</li> </ol>                                                                                                 |           |             |       |

**Reference Book(s):**

1. David E. Simon, An Embedded Software Primer, Addison-Wesley.
2. Shibu K.V., Introduction to Embedded Systems, McGraw Hill.

| Course Articulation Matrix (CAM): |             |     |     | U24EC602D: EMBEDDED SYSTEM DESIGN |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|-----------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                               | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC602D.1 | 3   | 2   | 1                                 | 1    | 2    | 1   | -   | -   | -   | -    | -    | 2    | 2    |
| CO2                               | U24EC602D.2 | 2   | 2   | 3                                 | 2    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC602D.3 | 2   | 2   | 3                                 | 3    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC602D.4 | 1   | 2   | 2                                 | 3    | 3    | 3   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC602D                         |             | 2   | 2   | 2.25                              | 2.25 | 2.75 | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                   |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                    |                 |                                                 |                                                                                                         |
|-------------------------|------------------------------------------------------------------------------------|-----------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                            | Relevant<br>SDG | SDG<br>Description                              | Mapping Justification                                                                                   |
| CO1                     | Explain the fundamentals of embedded systems, their components, and applications.  | SDG4            | Quality Education                               | Provides foundational knowledge in embedded systems.                                                    |
| CO2                     | Apply hardware-software co-design principles to develop embedded applications.     | SDG9            | Industry, Innovation, Infrastructure            | Hardware-software co-design supports resilient digital infrastructure.                                  |
| CO3                     | Demonstrate real-time operating system concepts through practical implementations. | SDG8            | Decent Work & Economic Growth                   | RTOS skills enhance employability in embedded and IoT industries.                                       |
| CO4                     | Analyze advanced embedded technologies and their societal impact.                  | SDG 11          | Good Health, Sustainable Cities, Climate Action | Advanced embedded technologies enable healthcare devices, smart cities, and energy-efficient solutions. |

| DEEP LEARNING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |             |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | U24EC602E | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |             |       |
| <b>CO1 :</b> apply deep learning fundamentals and regularization techniques for tuning the performance of the deep learning models<br><b>CO2 :</b> build and analyze deep convolutional neural network models for image recognition<br><b>CO3 :</b> apply recurrent and recursive neural network architectures for handling long term dependencies and vanishing gradient problem<br><b>CO4 :</b> build deep learning models for computer vision, speech and natural language processing applications                                                                                                                              |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |             | 9 Hrs |
| <b>Introduction:</b> Why Deep Learning? Historical trends in deep learning and its performance, Deep feed forward networks Learning XOR, Gradient based learning, Hidden Units, Back propagations and other differentiation algorithms, Case study: Deep learning applications and societal impact<br><br><b>Regularization for Deep learning:</b> Parameters norm penalties, Norm penalties as constrained optimization, Regularization and under constrained problems, Dataset augmentation, Noise robustness, semi-supervised learning, multitask learning, Early stopping, Parameter tying and sharing, Sparse representations |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |             | 9 Hrs |
| <b>Optimization for Training Deep Models:</b> Pure optimization, challenges in neural network optimization, Basic optimization algorithms, Algorithms with adaptive learning rates<br><br><b>Convolutional Neural Networks:</b> Convolution operations, Motivation, Pooling, Convolution and pooling as an infinitely strong prior, Variants of the basic convolution functions, Structured outputs, Data types, Efficient convolution algorithms, random or unsupervised features, Deep Convolutional Models - AlexNet, VGG, InceptionNet, ResNet                                                                                 |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |             | 9 Hrs |
| <b>Transfer Learning:</b> Concept of Transfer Learning, Pretrained models, Fine tuning techniques, Generative Adversarial Network architecture, variants of GANs, Object Detection Models- Region based CNN, Fast RCNN – You Only Look Once – Single shot detector                                                                                                                                                                                                                                                                                                                                                                 |           |             |       |

**Recurrent Neural Networks:** Simple RNN, Bidirectional RNN, Deep RNN, Sequence models: Encoder- decoder, Sequence to Sequence architectures, Representation learning- Auto encoders, Advanced models - Transformers and Bidirectional Encoder Representations from Transformers (BERT)

#### UNIT-IV

9 Hrs

**Recursive Neural networks:** Architecture, Challenges of long-term dependencies, Echo state networks, Long short- term memory, Gated RNNs, optimization for long term dependencies, Explicit memory

**Practical Methodology:** Performance Metrics, Default baseline models, debugging strategies, selecting hyper parameters- manual hyper parameter tuning, automatic hyper parameter optimization algorithms- Grid search ,Random Search

#### TextBook(s):

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, *Deep Learning*, 1<sup>st</sup> edition, MIT Press, 2017(Chapters 1 ,6 to 12)
2. Michael Nielsen, *Neural Networks and Deep Learning*, Determination Press, 1<sup>st</sup> edition, 2013.

#### Reference Book(s):

1. Deng & Yu, *Deep Learning: Methods and Applications*, 1<sup>st</sup> edition, Now Publisher, USA, 2013
2. Antonio Gulli, Amita Kapoor, Sujit Pal, *Deep Learning with TensorFlow 2.0 and Keras*, 2<sup>nd</sup> edition, Mumbai: Packt, 2019
3. Sebastian Raschka, Vahid Mirjalili - *Python Machine Learning*, 2<sup>nd</sup> edition, Mumbai: Packt, 2019

#### Web and Video link(s):

[ps://onlinecourses.nptel.ac.in/noc20\\_cs62/preview](https://onlinecourses.nptel.ac.in/noc20_cs62/preview), NPTEL Video Lecture on Deep Learning by Prof. Prabir Kumar Biaswas, Professor of EEE, IIT Kharagpur.

| Course Articulation Matrix (CAM): |             |     |     | U24EC602E : DEEP LEARNING |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|---------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                       | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC602E.1 | 2   | 2   | 2                         | 1   | -   | 1   | -   | 1   | 1   | 1    | -    | 2    | 2    |
| CO2                               | U24EC602E.2 | 2   | 2   | 1                         | 2   | 2   | -   | -   | 1   | 1   | 1    | -    | 2    | 2    |
| CO3                               | U24EC602E.3 | 2   | 2   | 1                         | 2   | 2   | -   | -   | 1   | 1   | 1    | -    | 2    | 2    |
| CO4                               | U24EC602E.4 | -   | 2   | 2                         | 3   | 2   | -   | 1   | 1   | 1   | 1    | 1    | 2    | 2    |
| U24EC602E                         |             | 2   | 2   | 1.5                       | 2   | 2   | 1   | 1   | 1   | 1   | 1    | 1    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                           |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                    |                 |                                         |                                                                                                         |
|-------------------------|--------------------------------------------------------------------|-----------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>            | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                   |
| CO1                     | Apply deep learning fundamentals and regularization techniques for | SDG9            | Industry, Innovation and Infrastructure | Deep learning fundamentals and optimization techniques enable the development of efficient and scalable |

| CO-SDG Alignment Matrix |                                                                                                      |                 |                                         |                                                                                                                                                                                                |
|-------------------------|------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                              | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                          |
|                         | tuning model performance                                                                             |                 |                                         | AI models, supporting innovation in industrial applications and intelligent systems.                                                                                                           |
| CO2                     | Build and analyze convolutional neural network models for image recognition                          | SDG3            | Good Health and Well-being              | CNN-based image recognition is widely used in medical imaging applications such as disease diagnosis and detection, improving healthcare quality and early intervention.                       |
| CO3                     | Apply recurrent and recursive neural network architectures for handling long-term dependencies       | SDG9            | Industry, Innovation and Infrastructure | RNN and advanced architectures support applications like speech recognition, predictive analytics, and automation systems, contributing to technological advancement and smart infrastructure. |
| CO4                     | Build deep learning models for computer vision, speech, and natural language processing applications | SDG11           | Sustainable Cities and Communities      | Deep learning applications such as smart surveillance, traffic management, and intelligent communication systems contribute to building safer, efficient, and sustainable urban environments.  |

## SENSORS AND ACTUATORS FOR IoT

|                                        |                  |                    |            |
|----------------------------------------|------------------|--------------------|------------|
| <b>Class:</b> B. Tech. VI – Semester   |                  | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC602F</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36 Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** Explain the fundamentals of sensors and actuators, their characteristics, interfacing principles and signal conditioning for IoT applications.
- CO2 :** Apply various analog and digital sensors to measure physical parameters and acquire data for IoT systems.
- CO3 :** Analyze actuator types and driver circuits for controlling physical processes in IoT applications.
- CO4 :** Integrate sensors and actuators with IoT platforms for real-time monitoring and automation.

### UNIT-I

**9 Hrs**

**Introduction to Sensors and Actuators:** Definition, need in IoT, classification of sensors and actuators, criteria for selecting sensors and actuators.

**Sensor Characteristics:** Range, accuracy, precision, resolution, sensitivity, linearity, hysteresis, response time, calibration.

**Interfacing and Signal Conditioning:** Analog vs digital signals, signal conditioning techniques – amplification, filtering, isolation, ADC and DAC, basic interfacing concepts for IoT.

### UNIT-II

**9 Hrs**

**Analog Sensors:** Temperature (Thermistor, RTD, Thermocouple), Light (LDR, Photodiode), Pressure (Strain gauge, Piezoelectric), Humidity, Gas sensors – working principle, specifications and applications.

**Digital Sensors:** Ultrasonic, PIR Motion, IR, Accelerometer, Gyroscope, Magnetometer, GPS, Touch and Proximity sensors – working principle, features and interfacing (I2C, SPI, UART).

**Sensor Data Acquisition:** Sampling and quantization, sensor data formats, noise and error sources, basic filtering techniques.

### UNIT-III

**9 Hrs**

**Actuators:** Types – Electrical (DC motor, Stepper motor, Servo motor, Solenoid), Mechanical, Thermal (Heater), Optical (LED, LCD), Audio (Buzzer, Speaker) – working principle and applications.

**Actuator Driver Circuits:** Transistor switching, MOSFET drivers, H-bridge driver, PWM control.

**Control of Actuators:** On/off control, speed control of DC motor, position control of servo motor, brightness control of LED

| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 9 Hrs |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <p><b>Sensors and Actuators in IoT Systems:</b> Block diagram of IoT system, role of sensors and actuators in data acquisition and automation.</p> <p><b>Interfacing with IoT Platforms:</b> Interfacing sensors and actuators with Arduino/ESP32/Raspberry Pi, GPIO, ADC, PWM, I2C, SPI, UART protocols.</p> <p><b>IoT Applications:</b> Smart home, industrial automation, smart agriculture, healthcare, environmental monitoring.</p>                                                                                                          |       |
| <p><b>TextBook(s):</b></p> <ol style="list-style-type: none"> <li>1. Vijay Madiseti, ArshdeepBahga, Internet of Things (A Hands-on Approach), Universities Press, 1st edition, 2015, India.</li> <li>2. David E. Culler, Jaswinder Pal Singh, Anirban Maitra, Internet of Things: Architectures and Protocols, Morgan Kaufmann (Elsevier), 1st edition, 2019, USA.</li> </ol>                                                                                                                                                                      |       |
| <p><b>Reference Book(s):</b></p> <ol style="list-style-type: none"> <li>1. S. R. Wate, Sensors and Actuators, Pearson Education India, 2nd edition, 2011, Noida.</li> <li>2. D. Patranabis, Sensors and Transducers, PHI Learning Private Limited, 2nd edition, 2015, New Delhi.</li> <li>3. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, 1st edition, 2017, New Delhi.</li> <li>4. John G. Webster, Measurement, Instrumentation and Sensors Handbook, CRC Press, 2nd edition, 2014, USA.</li> </ol> |       |
| <p><b>Web and Video link(s):</b></p> <ol style="list-style-type: none"> <li>1. <a href="https://nptel.ac.in/courses/108/106/108106152/">https://nptel.ac.in/courses/108/106/108106152/</a></li> <li>2. <a href="https://www.youtube.com/playlist?list=PLzD-VY8bTCbTqRMUu8fHhLzzLz-2iOltb">https://www.youtube.com/playlist?list=PLzD-VY8bTCbTqRMUu8fHhLzzLz-2iOltb</a></li> </ol>                                                                                                                                                                  |       |

| Course Articulation Matrix (CAM): |             |     |      | U24EC602F :Sensors and Actuators for IoT |      |      |     |     |     |      |      |      |      |      |
|-----------------------------------|-------------|-----|------|------------------------------------------|------|------|-----|-----|-----|------|------|------|------|------|
| CO                                |             | PO1 | PO2  | PO3                                      | PO4  | PO5  | PO6 | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC602F.1 | 3   | 2    | 1                                        | 2    | 3    | -   | -   | -   | -    | 1    | 1    | 2    | 2    |
| CO2                               | U24EC602F.2 | 3   | 3    | 2                                        | 3    | 3    | -   | 1   | -   | 1    | 1    | 1    | 3    | 3    |
| CO3                               | U24EC602F.3 | 3   | 3    | 2                                        | 3    | 2    | -   | 1   | -   | 2    | -    | 1    | 3    | 2    |
| CO4                               | U24EC602F.4 | 3   | 3    | 3                                        | 3    | 3    | 1   | 1   | -   | 2    | 1    | 1    | 3    | 3    |
| U24EC602F                         |             | 3   | 2.75 | 2                                        | 2.75 | 2.75 | 1   | 1   | -   | 1.67 | 1    | 1    | 2.75 | 2.5  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |      |                                          |      |      |     |     |     |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                |                 |                                         |                                                                                                                                                          |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                        | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                    |
| CO1                     | Explain the fundamentals of sensors and actuators, their characteristics, interfacing principles and signal conditioning for IoT applications. | SDG 9           | Industry, Innovation and Infrastructure | Understanding sensor and actuator technologies builds the foundation for innovative IoT systems, smart infrastructure, and modern industrial automation. |

| CO-SDG Alignment Matrix |                                                                                                          |                  |                                                                                |                                                                                                                                                                        |
|-------------------------|----------------------------------------------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                  | Relevant<br>SDG  | SDG<br>Description                                                             | Mapping Justification                                                                                                                                                  |
| CO2                     | Apply various analog and digital sensors to measure physical parameters and acquire data for IoT systems | SDG 3            | Good Health and Well-being                                                     | Sensor-based data acquisition supports healthcare monitoring, environmental sensing,                                                                                   |
|                         |                                                                                                          | SDG 11           | Sustainable Cities and Communities                                             | smart transportation, and smart city applications for improved quality of life.                                                                                        |
| CO3                     | Analyze actuator types and driver circuits for controlling physical processes in IoT applications        | SDG 7            | Affordable and Clean Energy                                                    | Efficient actuator control and driver circuits help optimize energy usage, automation efficiency, and sustainable industrial operations.                               |
| CO4                     | Integrate sensors and actuators with IoT platforms for real-time monitoring and automation               | SDG 9,<br>SDG 11 | Industry, Innovation and Infrastructure;<br>Sustainable Cities and Communities | IoT-based integration enables smart automation, intelligent monitoring systems, and sustainable solutions in homes, industries, agriculture, and urban infrastructure. |

# DIGITAL SIGNAL PROCESSING AND APPLICATIONS

|                                        |                 |                    |            |
|----------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. VI – Semester   |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC603</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>2-1-0-3</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36 Hrs</b>   | <b>ESE:</b>        | <b>40%</b> |

## Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** solve problems on DFT of a DT sequence, circular convolution using DFT & IDFT, 2, 4 & 8-point FFT of a sequence using radix-2 DIT & DIF algorithms
- CO2 :** design a linear-phase FIR filter with a prescribed magnitude response using windowing & frequency sampling methods
- CO3 :** design an IIR Butterworth & Chebyshev digital filter meeting the required specifications by performing impulse invariance/bilinear transformation
- CO4 :** analyze the performance of LMS & RLS algorithms for updating weight vectors and utilize adaptive filters for noise cancellation

### UNIT-I

**9 Hrs**

**Discrete Fourier Transform (DFT):** Frequency domain sampling and reconstruction of discrete-time signals, DFT, properties of DFT, Circular convolution, Inverse DFT (IDFT), Linear filtering methods based on DFT, Frequency analysis of signals using DFT, Relation between DFT and other transforms

**Fast Fourier Transform (FFT):** Computational complexity of DFT, Introduction to FFT, Radix-2 FFT algorithms, Decimation-in-time FFT algorithm, Decimation-in-frequency FFT algorithm, Inverse DFT using FFT

### UNIT-II

**9 Hrs**

**Filter concepts:** Causality and its implications, Paley-Wiener theorem, Magnitude characteristics of physically realizable filters, Phase delay, Group delay, Zero phase filter, Linear phase filters, Desirability of linear phase, Filter specifications

**Finite Impulse Response (FIR) filters:** Introduction to FIR filters, Inherent stability of FIR filters, Symmetric and anti-symmetric FIR filters, Design of linear phase FIR filters - Windowing method (rectangular window, triangular window, hamming window & Hanning window) and frequency sampling method

### UNIT-III

**9 Hrs**

**Infinite Impulse Response (IIR) Filters:** Realizability of ideal filter, Introduction to IIR filters, Design of IIR digital filters from analog filter specifications, Mapping techniques - Impulse invariance and bilinear transformation; IIR digital filter design using Butterworth and Chebyshev approximations, Frequency transformations, Comparison of Butterworth and Chebyshev filters, Comparison of IIR and FIR filters

### UNIT-IV

**9 Hrs**

**Correlation:** Correlation of discrete time signals, Auto correlation, Properties of auto correlation function, Cross correlation, Matrix form representation, Example problems for computation of correlation functions

**Adaptive Filters:** Concepts of adaptive filtering, configurations, Basic wiener filter theory, Cost function, Error performance surface, Basic LMS algorithm & its implementation, Practical limitations of basic LMS algorithm, RLS algorithm, Limitations of RLS algorithm

**Applications of Adaptive filters:** Fetal monitoring - Cancelling of maternal ECG during

labour; Adaptive telephone echo cancellation

**TextBook(s):**

1. John G.Proakis&D.G.Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson education, 4/e, 2007. (Chapters 2, 7, 8, 10)
2. Ifeachor, Digital Signal Processing-A practical Approach, Pearson Education India, 4/e, 2013. (Chapter 10)

**Reference Book(s):**

1. A. V. Oppenheim & R. W. Schaffer, "Discrete-Time Signal Processing", PHI, 2/e, 1999.
2. Sanjit K. Mitra, "Digital Signal Processing - A Computer Based Approach", TMH, 2/e, 2002.
3. Johnny R. Johnson, "Introduction to Digital Signal Processing", PHI, 1/e, 2001.
4. AdreasAntanio, "Digital filter Analysis and Design", TMH, 4/e,1988.

**Web and Video link(s):**

[https://youtu.be/0ENnxVXEv\\_U?si=MUIBDIvm49lnQopu](https://youtu.be/0ENnxVXEv_U?si=MUIBDIvm49lnQopu); NPTEL Video Lecture on Digital Signal Processing by Prof. Vikram M.Gadre, Professor of EEE, IIT Bombay

| Course Articulation Matrix (CAM): |            |     |     | U24EC603 : DIGITAL SIGNAL PROCESSING AND APPLICATIONS |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|-------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                                                   | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC603.1 | 2   | 2   | 1                                                     | 1   | -   | -   | -   | -   | -   | -    | 2    | 2    | 1    |
| CO2                               | U24EC603.2 | 2   | 2   | 1                                                     | 1   | -   | -   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC603.3 | 1   | 1   | 1                                                     | 1   | -   | -   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC603.4 | 1   | 1   | 1                                                     | 1   | 1   | -   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC603                          |            | 1.5 | 1.5 | 1                                                     | 1   | 1   | -   | -   | -   | -   | -    | 2    | 2    | 1.75 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                                       |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                    |                 |                                         |                                                                                                                                                      |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                            | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                |
| CO1                     | solve problems on DFT of a DT sequence, circular convolution using DFT & IDFT, 2, 4 & 8-point FFT of a sequence using radix-2 DIT & DIF algorithms | SDG9            | Industry, Innovation and Infrastructure | DFT and FFT techniques are fundamental in signal analysis, automation and real time digital processing systems used in industries and infrastructure |
| CO2                     | design a linear-phase FIR filter with a prescribed magnitude response using windowing & frequency sampling methods                                 | SDG7            | Affordable and Clean Energy             | Efficient FIR filter design reduces signal distortion and improves energy efficient processing in communication and embedded systems                 |
| CO3                     | design an IIR Butterworth & Chebyshev digital filter meeting the required specifications by performing impulse invariance/bilinear transformation  | SDG9            | Industry, Innovation and Infrastructure | IIR filters are widely used in wireless communication, biomedical instrumentation, radar and industrial signal processing applications               |
| CO4                     | analyze the performance of LMS & RLS algorithms for                                                                                                | SDG3            | Good Health and Well being              | Adaptive filtering and noise cancellation techniques are extensively used in medical                                                                 |

| CO-SDG Alignment Matrix |                                                                             |                 |                    |                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------|-----------------|--------------------|-----------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                     | Relevant<br>SDG | SDG<br>Description | Mapping Justification                                                                                     |
|                         | updating weight vectors and utilize adaptive filters for noise cancellation |                 |                    | signal processing, hearing aids, ECG analysis and speech enhancement systems for health care applications |

## SYSTEM VERILOG FOR DESIGN AND VERIFICATION

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                    |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>U24EC604</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>2-1-0-3</b>  | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>36 Hrs</b>   | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                    |              |
| <p><b>CO1 :</b> examine and utilize System Verilog’s key features, advanced data types and procedural constructs to model digital systems</p> <p><b>CO2 :</b> design and manipulate arrays, queues, and linked lists to build modular and reusable verification environments</p> <p><b>CO3 :</b> construct class-based verification components using OOP principles and implement constrained randomization to achieve coverage-driven verification.</p> <p><b>CO4 :</b> employ functional coverage strategies and build UVM-based testbench architectures to verify complex digital designs with reusable and scalable methodologies</p> |                 |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                    | <b>9 Hrs</b> |
| <b>Introduction to System Verilog:</b> Key features in System Verilog, Advantages of using System Verilog over Verilog for Verification, New Data Types in System Verilog- 2 state and 4 state, User Defined Data types, Enumerated Data types, structures and unions, class types, wire Concatenation and Replication operators, Procedural Blocks.                                                                                                                                                                                                                                                                                      |                 |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                    | <b>9 Hrs</b> |
| <b>Arrays:</b> Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Multi-dimensional arrays, Linked lists, Array Methods, choosing a storage type, Creating New Types with typedef, Creating User-Defined Structures, Time Values, Interface.                                                                                                                                                                                                                                                                                                                                                                                  |                 |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                    | <b>9 Hrs</b> |
| <p><b>Basics of OOPs:</b> OOP Terminology, Basic OOP Concepts, Class, Class Declaration &amp; Creation of Object, this Keyword, Creating New Objects, Object Deallocation, Using Objects, Static Variables vs. Global Variables, Class Methods.</p> <p><b>Randomization:</b> Introduction, What to Randomize, Randomization in System Verilog, Constraint Details, Equivalence Expressions, Weighted Distributions, Conditional Constraints.</p>                                                                                                                                                                                          |                 |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                    | <b>9 Hrs</b> |
| <p>Functional Coverage, Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example</p> <p><b>UVM:</b> UVM Test Bench architecture, UVM Factory, UVM Components. Modeling Finite State Machines with System Verilog: Modeling state machines with enumerated type, representing state encoding with enumerated types, Reversed case statements with enumerated types.</p>                                                                                                                                                                                                                                          |                 |                    |              |
| <b>TextBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                    |              |

1. Spear, Chris. *System Verilog for verification: a guide to learning the testbench language features*. Boston, MA: Springer US, 2006.

**Reference Book(s):**

1. Sutherland, Stuart, Simon Davidmann, and Peter Flake, *System Verilog for Design: A guide to using System Verilog for hardware design and modelling*. Boston, MA: Springer US, 2006.
2. Bergeron, Janick, et al. *Verification methodology manual for System Verilog*. Boston, MA: Springer US, 2006.

**Web and Video link(s):**

[tel.ac.in/courses/117103125](http://tel.ac.in/courses/117103125); NPTEL Video Lecture on VLSI Design Verification and test by Prof. Santhosh biswas, Prof. Jatindra Kumar Deka, Prof. Arnab Sarkar, IIT Guwahati.

| Course Articulation Matrix (CAM): |            |     |     | U24EC604 : SYSTEM VERILOG FOR DESIGN AND VERIFICATION |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|-------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                                                   | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC604.1 | 3   | 2   | 3                                                     | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO2                               | U24EC604.2 | 3   | 2   | 3                                                     | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO3                               | U24EC604.3 | 2   | 3   | 3                                                     | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| CO4                               | U24EC604.4 | 2   | 3   | 3                                                     | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| U24EC604                          |            | 2.5 | 2.5 | 3                                                     | 2.5 | 3   | 1   | 1   | 2.5 | 1.5 | 2    | 2.5  | 3    | 2.5  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                                       |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                              |                 |                                                                                                  |                                                                                                                                                                                          |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                      | Relevant<br>SDG | SDG<br>Description                                                                               | Mapping Justification                                                                                                                                                                    |
| CO1                     | examine and utilize SystemVerilog's key features, advanced data types and procedural constructs to model digital systems                                     | SDG9            | Build infrastructure, promote inclusive and sustainable industrialization, and foster innovation | RTL design using SystemVerilog promotes innovation in semiconductor and digital infrastructure development, supporting industrial automation and sustainable technology growth.          |
| CO2                     | design and manipulate arrays, queues, and linked lists to build modular and reusable verification environments                                               | SDG9            | Industry, Innovation, and Infrastructure                                                         | Modular connectivity through interfaces and clocking blocks enhances design scalability and interoperability, contributing to reliable and innovative electronic infrastructure systems. |
| CO3                     | construct class-based verification components using OOP principles and implement constrained randomization to achieve coverage-driven verification.          | SDG12           | Ensure sustainable consumption and production patterns                                           | System Verilog's OOP and randomization techniques promote resource efficiency, reuse, and reduced waste in verification processes                                                        |
| CO4                     | employ functional coverage strategies and build UVM-based testbench architectures to verify complex digital designs with reusable and scalable methodologies | SDG11           | Make cities and human settlements inclusive, safe, resilient, and sustainable                    | Coverage-driven verification ensures reliable and fault-tolerant electronic systems used in smart city applications, enhancing safety and sustainability in urban technology ecosystems. |

| <b>ANTENNAS AND WAVE PROPAGATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                    |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>U24EC605</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>2-1-0-3</b>  | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>36 Hrs</b>   | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |                    |              |
| <b>CO1 :</b> discuss radiation mechanism & fundamental characteristics of antennas<br><b>CO2 :</b> design two element & n-element arrays<br><b>CO3 :</b> build UHF, VHF & microwave antennas<br><b>CO4 :</b> distinguish ground wave, space wave & sky wave propagation                                                                                                                                                                                                                                                                                                                   |                 |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                    | <b>9 Hrs</b> |
| <b>Linear Wire Antennas :</b> Introduction to antennas and radiation mechanism, Retarded Potentials, Radiation from Small Dipole, Half wave Dipole and Quarter wave Monopole, Current Distribution, Electric and Magnetic field components, Radiated Power, Radiation Resistance<br><b>Antenna Properties:</b> Radiation pattern, beam width, Radiation intensity, gain and directivity, bandwidth, Polarization, Antenna impedance, effective length, aperture concepts and types, efficiency, front to back ratio, Reciprocity theorem applied to antennas, Friis Transmission equation |                 |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                    | <b>9 Hrs</b> |
| <b>Linear Antenna Arrays:</b> Two-element arrays –different cases; N-element Uniform Linear Array- Broadside and End fire arrays, Characteristics -Directivity and BWFN, comparison, Principle of pattern Multiplication, Binomial Array, Concept of phased array.<br><b>Non-Resonant Radiators:</b> Introduction, Travelling wave radiators - Basic concepts, V and Inverted V- antennas, Rhombic antenna- Construction details & design considerations                                                                                                                                  |                 |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                    | <b>9 Hrs</b> |
| <b>VHF, UHF and Microwave Antennas:</b> Yagi-Uda antenna- Parasitic elements & Folded Dipole, Plane sheet and Corner Reflectors, Paraboloidal Reflectors - Characteristics, Types of feeds- Offset feed and Cassegrain Feeds, Horn Antennas- Types, Design considerations, Optimum Horns, Helical Antenna, Concept of Microstrip antenna-Introduction to Rectangular Microstrip antenna, advantages, disadvantages and applications                                                                                                                                                       |                 |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                    | <b>9 Hrs</b> |
| <b>Wave Propagation:</b> Introduction, Factors involved in Wave Propagation, Ground Wave Propagation-Characteristics, Wave tilt, Flat earth considerations, Ionosphere Formation of layers and mechanism of propagation, Reflection and Refraction mechanisms, Critical Frequency, Maximum Usable Frequency, Optimum working frequency, Skip distance, Virtual Height, Space wave propagation- M Curves and Duct Propagation, Tropospheric Scattering                                                                                                                                     |                 |                    |              |
| <b><u>TextBook(s):</u></b><br>1. E.C. Jordan and K.G. Balmain, <i>Electromagnetic Waves and Radiating Systems</i> , 2 <sup>nd</sup> ed., New Delhi:Prentice Hall of India(PHI), 2001.(Chapters 10,11,12)                                                                                                                                                                                                                                                                                                                                                                                  |                 |                    |              |

- John D Kraus, Ronald J Marhefka and Ahmad Khan. Kraus, *Antennas and Wave Propagation*, 4<sup>th</sup> ed., New Delhi: Tata McGraw Hill Education, 2011. (Chapters 2,4 to 9,14,22,23,24,25)

**Reference Book(s):**

- Constantine A. Balanis, *Antenna Theory*, 2<sup>nd</sup> ed., New York: John Wiley & Sons, 1997.
- G.S.N. Raju, *Antennas and Wave Propagation*, 1<sup>st</sup> ed., New Delhi: Pearson, 2004.
- K.D. Prasad, *Antenna and Wave Propagation*, 3<sup>rd</sup> ed., New Delhi: Satya Prakashan, 1996.
- F.E. Terman, *Electronic and Radio Engineering*, 4<sup>th</sup> ed., New York: McGraw-Hill, 1955.
- R.L. Yadav, *Antennas and Wave Propagation*, 2<sup>nd</sup> ed., New Delhi: Prentice Hall of India (PHI), 2013

**Web and Video link(s):**

[https://youtu.be/wx\\_tIvaajAI?si=uwrCLJ\\_07ydmXvQU](https://youtu.be/wx_tIvaajAI?si=uwrCLJ_07ydmXvQU); NPTEL Video Lecture on Antennas and wave Propagation by Prof. Girish Kumar, Professor of EEE, IIT Bombay.

| Course Articulation Matrix (CAM): |            |     |     | U24EC605 : ANTENNAS AND WAVE PROPAGATION |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                                      | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC605.1 | 2   | 1   | 2                                        | -   | -   | -   | 1   | -   | -   | -    | -    | 1    | 2    |
| CO2                               | U24EC605.2 | 2   | 1   | 2                                        | -   | -   | -   | 1   | -   | -   | -    | -    | 1    | 1    |
| CO3                               | U24EC605.3 | 2   | 1   | 2                                        | -   | -   | -   | 1   | -   | -   | -    | 1    | 1    | 1    |
| CO4                               | U24EC605.4 | 2   | 1   | 2                                        | -   | -   | -   | 1   | -   | -   | -    | 1    | 1    | 1    |
| U24EC505                          |            | 2   | 1   | 2                                        | -   | -   | -   | 1   | -   | -   | -    | 1    | 1    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                          |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                       |                 |                                         |                                                                                                                                         |
|-------------------------|-----------------------------------------------------------------------|-----------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>               | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                   |
| CO1                     | discuss radiation mechanism & fundamental characteristics of antennas | SDG9            | Industry, Innovation and Infrastructure | Fundamentals of antenna concepts are essential for wireless communication, satellite and radar systems                                  |
| CO2                     | design two element & n-element arrays                                 | SDG7            | Affordable and Clean Energy             | Antenna array design improves signal directivity and transmission efficiency, reducing power consumption in communication systems       |
| CO3                     | build UHF, VHF & microwave antennas                                   | SDG9            | Industry, Innovation and Infrastructure | VHF, UHF and microwave antennas support modern wireless communication, IoT                                                              |
| CO4                     | distinguish ground wave, space wave & sky wave propagation            | SDG11           | Sustainable Cities and Communities      | Wave propagation principles enable reliable communication systems used in smart cities, disaster management and public safety networks. |

| UNIVERSAL HUMAN VALUES – II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                                       |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------|--------------|
| <b>Class:</b> B. Tech. VI – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  | <b>Branch:</b> Common to all branches |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>U24IK606B</b> | <b>Credits:</b>                       | <b>1</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>2-0-0-2</b>   | <b>CIE:</b>                           | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>24Hrs</b>     | <b>ESE:</b>                           | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                                       |              |
| <b>CO1:</b> describe harmony within the individual by understanding the distinct roles of the self and the body<br><b>CO2 :</b> analyze values in human relationships and apply the principles of justice, mutual happiness, and harmony in family and society.<br><b>CO3:</b> explain the interconnectedness of nature and existence and evaluate the concept of coexistence and mutual fulfilment among all orders of nature.<br><b>CO4:</b> apply professional ethics and sustainable practices in engineering and professional activities for societal and environmental well-being. |                  |                                       |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                  |                                       | <b>6 Hrs</b> |
| <b>Course Introduction</b> - Need, Basic guidelines, Content and Process for value education<br><b>Self-exploration:</b> ‘Natural acceptance’ and Experiential validation, Basic human aspirations, Right understanding, Relationship and Physical facility, fulfilment of aspirations, Understanding happiness and prosperity, Harmony at various levels<br><b>Understanding Harmony in the Human Being:</b> Harmony in myself, Understanding human being, Understanding the harmony of self with the body, Harmony in self; Health; Program for self and health                        |                  |                                       |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                                       | <b>6 Hrs</b> |
| <b>Understanding Harmony in the Family:</b> Harmony in human - human Relationship, Understanding values in human-human relationship, Meaning of Justice (universal values in relationships), Mutual happiness<br><b>Understanding Harmony in the Society:</b> Harmony in the society, Visualizing a universal harmonious order in society- Undivided society, Universal order- from family to world family                                                                                                                                                                               |                  |                                       |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |                                       | <b>6 Hrs</b> |
| <b>Understanding Harmony in the Nature:</b> Whole existence as coexistence, Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature, Recyclability and Self-regulation in nature,<br><b>Understanding Harmony in the Existence:</b> Understanding existence as co-existence of mutually interacting units in all- pervasive space; Holistic perception of harmony at all levels of existence.                                                                                                                                  |                  |                                       |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                                       | <b>6 Hrs</b> |
| <b>Professional Ethics:</b> People friendly and eco-friendly production systems, Appropriate technologies and management patterns.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                                       |              |

**Case Studies:** Case studies of typical holistic technologies, Management models and production systems

**Textbooks:**

1. R.R. Gaur, R. Sangal and G. P. Bagaria, *Human Values and Professional Ethics*, New Delhi Excel Books, 2010.

**Reference Book(s):**

1. A.Nagaraj, *Jeevan Vidya: Ek Parichaya*, Raipur: Jeevan Vidya Prakashan, Amarkantak, 2018.
2. A.N.Tripathi, *Human Values*, New Age International Publisher, 3<sup>rd</sup> ed., New Delhi, 2019.
3. M.Govindrajran, S.Natrajan & V.S.Senthil Kumar, *Engineering Ethics (includes Human Values)*, PHI Learning Pvt. Ltd., 12<sup>th</sup> ed., Haryana, 2011.
4. Jayshree Suresh, B. S. Raghavan, *Human Values & Professional Ethics*, 4<sup>th</sup> ed., S. Chand & Co. Ltd., New Delhi, 2012.

**Additional Resources:**

1. A set of DVDs containing-Video of Teachers' Orientation Program-PPTs of Lectures and Practice Sessions (*Audio-visual material for use in the practice sessions*)

**Web and Video link(s):**

1. <https://fdp-si.aicte-india.org/UHVIL.php>

| Course Articulation Matrix |             |     |      |     | U24IK606B: Universal Human Values - II |     |      |     |      |     |      |      |      |      |
|----------------------------|-------------|-----|------|-----|----------------------------------------|-----|------|-----|------|-----|------|------|------|------|
| CO                         |             | PO1 | PO2  | PO3 | PO4                                    | PO5 | PO6  | PO7 | PO8  | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                        | U24IK606B.1 | 2   | 1    | -   | -                                      | -   | 1    | -   | 3    | -   | -    | -    | 1    | 1    |
| CO2                        | U24IK606B.2 | -   | 2    | -   | -                                      | -   | 3    | -   | 3    | 2   | 2    | -    | -    | 1    |
| CO3                        | U24IK606B.3 | 1   | 2    | -   | -                                      | -   | 2    | 3   | 2    | -   | -    | -    | 1    | 1    |
| CO4                        | U24IK606B.4 | 1   | 2    | -   | -                                      | -   | 3    | 3   | 3    | 2   | 2    | 3    | 2    | 1    |
| U24IK606B                  |             | 1   | 1.75 | -   | -                                      | -   | 2.25 | 1.5 | 2.75 | 1   | 1    | 0.75 | 1    | 1    |

| CO-SDG Alignment Matrix |                                                                                                                                                   |                 |                                        |                                                                                                               |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                           | Relevant<br>SDG | SDG Description                        | Mapping Justification                                                                                         |
| CO1                     | describe harmony within the individual by understanding the distinct roles of the self and the body                                               | SDG 4           | Quality Education                      | 1. Develops self-awareness, values, ethical thinking, and holistic education for responsible citizenship.     |
| CO2                     | analyze values in human relationships and apply the principles of justice, mutual happiness, and harmony in family and society.                   | SDG 16          | Peace, Justice and Strong Institutions | 1. Promotes justice, mutual respect, harmonious relationships, and peaceful societies.                        |
| CO3                     | explain the interconnectedness of nature and existence and evaluate the concept of coexistence and mutual fulfillment among all orders of nature. | SDG 13, SDG 15  | Climate Action; Life on Land           | 1. Enhances understanding of ecological balance, coexistence, environmental sustainability, and conservation. |

| CO-SDG Alignment Matrix |                                                                                                                                           |                  |                                                                                    |                                                                                                                             |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                   | Relevant<br>SDG  | SDG Description                                                                    | Mapping Justification                                                                                                       |
| CO4                     | apply professional ethics and sustainable practices in engineering and professional activities for societal and environmental well-being. | SDG 9,<br>SDG 12 | Industry, Innovation and Infrastructure;<br>Responsible Consumption and Production | 1. Encourages ethical professional practices, sustainable technologies, and environmentally responsible production systems. |

# DIGITAL SIGNAL PROCESSING AND APPLICATIONS LABORATORY

|                                        |                 |                    |            |
|----------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. VI - Semester   |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC607</b> | <b>Credits:</b>    | <b>1</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>0-0-2-2</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>24Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |

## Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** develop programs to compute DFT and FFT of the sequences
- CO2 :** develop programs to design FIR filter using windowing techniques
- CO3 :** develop programs to design IIR butterworth and Chebyshev filters
- CO4 :** develop programs to find correlation function and design wiener filter using LMS,RLS algorithms

### Experiment-1

1. Perform mathematical operations on signals.
2. Develop a program to generate Unit step, Ramp, Impulse, Exponential and Sinusoidal Signals
3. Perform scaling, shifting and delay operations on the sequences

### Experiment-2

1. Develop a program to demonstrate AMDSB and AMDSB-SC waveforms.
2. Develop a program to demonstrate FM waveforms.
3. Develop a program to Compute DFT/IDFT of a sequence.
4. Develop a program to Compute FFT /IFFT of a sequence.
5. Develop a program to perform Linear Convolution of two finite length sequences.

### Experiment-3

1. Develop a program to demonstrate power spectrum of a given sequence.
2. Develop a program to design FIR LP filter using windows.
3. Develop a program to design FIR HP filter using windows (rectangular window, triangular window, hamming window &Hanning window).

### Experiment-4

1. Developa program to design IIR Lowpass Butterworth Filter.
2. Develop a program to design IIR High Pass Chebyshev Filter.

### Experiment-5

1. Developa program to demonstrate autocorrelation of two given sequences.
2. Developa program to demonstrate cross correlation of two given sequences.

3. Develop a program to design Wiener filter.

**TextBook(s):**

1. John G. Proakis & D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Education, 4/e, 2007. (Chapters 2, 7, 8, 10)
2. Iffachor, Digital Signal Processing-A practical Approach, Pearson Education India, 4/e, 2013. (Chapter 10)

**Reference Book(s):**

1. A. V. Oppenheim & R. W. Schaffer, "Discrete-Time Signal Processing", PHI, 2/e, 1999.
2. Sanjit K. Mitra, "Digital Signal Processing - A Computer Based Approach", TMH, 2/e, 2002.
3. Johnny R. Johnson, "Introduction to Digital Signal Processing", PHI, 1/e, 2001.

**Web and Video link(s):**

[https://youtu.be/0ENnxVXE\\_V?si=MUIBDIvm49lnQopu](https://youtu.be/0ENnxVXE_V?si=MUIBDIvm49lnQopu); NPTEL Video Lecture on Digital Signal Processing by Prof. Vikram M. Gadre, Professor of EEE, IIT Bombay

**Laboratory Manual:**

1. Digital Signal Processing Laboratory Manual, Department of ECE, KITSW

| Course Articulation Matrix (CAM): |            |      |     | U24EC607: DIGITAL SIGNAL PROCESSING & APPLICATIONS LABORATORY |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|------|-----|---------------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1  | PO2 | PO3                                                           | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC607.1 | 2    | 2   | 1                                                             | 1   | -   | -   | -   | -   | -   | -    | 2    | 2    | 1    |
| CO2                               | U24EC607.2 | 2    | 2   | 1                                                             | 1   | -   | -   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC607.3 | 1    | 1   | 1                                                             | 1   | -   | -   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC607.4 | 1    | 1   | 1                                                             | 1   | 1   | -   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC607                          |            | 1.75 | 1.5 | 1.5                                                           | 1   | 1   | -   | -   | -   | -   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |     |                                                               |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                    |              |                                         |                                                                                                                                                      |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to</i>                                                                                               | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                |
| CO1                     | solve problems on DFT of a DT sequence, circular convolution using DFT & IDFT, 2, 4 & 8-point FFT of a sequence using radix-2 DIT & DIF algorithms | SDG9         | Industry, Innovation and Infrastructure | DFT and FFT techniques are fundamental in signal analysis, automation and real time digital processing systems used in industries and infrastructure |
| CO2                     | design a linear-phase FIR filter with a prescribed magnitude response using windowing & frequency sampling methods                                 | SDG7         | Affordable and Clean Energy             | Efficient FIR filter design reduces signal distortion and improves energy efficient processing in communication and embedded systems                 |
| CO3                     | design an IIR Butterworth & Chebyshev digital filter meeting the required specifications by performing impulse invariance/bilinear transformation  | SDG9         | Industry, Innovation and Infrastructure | IIR filters are widely used in wireless communication, biomedical instrumentation, radar and industrial signal processing applications               |
| CO4                     | analyze the performance of LMS & RLS algorithms for                                                                                                | SDG3         | Good Health and Well being              | Adaptive filtering and noise cancellation techniques are extensively                                                                                 |

| CO-SDG Alignment Matrix |                                                                             |                 |                    |                                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------|-----------------|--------------------|---------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to</i>                        | Relevant<br>SDG | SDG<br>Description | Mapping Justification                                                                                                     |
|                         | updating weight vectors and utilize adaptive filters for noise cancellation |                 |                    | used in medical signal processing, hearing aids, ECG analysis and speech enhancement systems for health care applications |

# SYSTEM VERILOG FOR DESIGN AND VERIFICATION LABORATORY

|                                        |                 |                    |            |
|----------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. VI – Semester   |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC608</b> | <b>Credits:</b>    | <b>1</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>0-0-2-2</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>24Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |

## Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** examine SystemVerilog language constructs and apply them in synthesizable RTL designs
- CO2 :** develop competence in structuring modular connectivity using interfaces, modports, and clocking blocks
- CO3 :** construct reusable UVM testbench components and generate transaction-level stimulus
- CO4 :** demonstrate expertise in building coverage-driven verification environments by integrating constrained randomization, functional coverage models, and scoreboard techniques

## Experiment-1

Implement arithmetic and logic operations using SystemVerilog constructs.

*Use **always\_comb** procedural block, Apply enumerated types for operation selection, Verify correctness with testbench outputs*

## Experiment-2

Model a finite state machine with unique/priority case statements.

*Define states for Red, Yellow, Green, Use synthesizable RTL constructs, Measure timing correctness with simulation waveforms*

## Experiment-3

Create modular connectivity using SystemVerilog interfaces.

*Define interface signals, Assign modports for driver/receiver roles, Validate modularity by connecting multiple modules*

## Experiment-4

Design a FIFO and validate with assertion checks.

*Implement FIFO read/write logic, Add assertions for underflow/overflow detection, Observe assertion triggers during simulation*

## Experiment-5

Use clocking blocks for clean signal synchronization.

*Define clocking block with input/output skew, Connect DUT and testbench via clocking block, Measure synchronization correctness*

## Experiment-6

|                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Build a UVM agent to verify UART communication.<br><i>Create driver, monitor, sequencer, Generate UART transactions, Measure functional correctness with scoreboard</i>                                                                                                                                                                                                                             |
| <b>Experiment-7</b>                                                                                                                                                                                                                                                                                                                                                                                 |
| Generate transaction-level stimulus with randomized fields.<br><i>Define sequence class with random variables, Apply constraints for valid packets, Observe randomized stimulus in DUT</i>                                                                                                                                                                                                          |
| <b>Experiment-8</b>                                                                                                                                                                                                                                                                                                                                                                                 |
| Develop functional coverage for request-grant signals.<br><i>Define covergroups and bins, Add cross coverage for request vs grant, Measure coverage percentage after simulation</i>                                                                                                                                                                                                                 |
| <b>Experiment-9</b>                                                                                                                                                                                                                                                                                                                                                                                 |
| Implement a scoreboard for DUT output checking.<br><i>Capture DUT outputs, Compare with expected results, Log mismatches for debugging</i>                                                                                                                                                                                                                                                          |
| <b>Experiment-10</b>                                                                                                                                                                                                                                                                                                                                                                                |
| Apply concurrent assertions in a design example.<br><i>Insert assert property constructs, Validate timing and protocol rules, Observe assertion failures in simulation</i>                                                                                                                                                                                                                          |
| <b>Experiment-11</b>                                                                                                                                                                                                                                                                                                                                                                                |
| Experiment with build, connect, run, and report phases.<br><i>Implement UVM testbench with phases, Track execution order, Measure simulation logs for phase transitions</i>                                                                                                                                                                                                                         |
| <b>Experiment-12</b>                                                                                                                                                                                                                                                                                                                                                                                |
| Construct reusable verification components.<br><i>Create parameterized driver/monitor classes, Reuse across multiple DUTs, Measure reduction in coding effort</i>                                                                                                                                                                                                                                   |
| <b><u>TextBook(s):</u></b><br><ol style="list-style-type: none"> <li>1. Taraate, Vaibbhav, <i>SystemVerilog for Hardware Description: RTL Design and Verification</i>. Springer Nature, 2020. (Chapters 1 to 4)</li> <li>2. Salemi Ray, <i>The UVM primer: An introduction to the universal verification methodology</i>. Boston Light Press, 2013.(Chapters 1 to 6, 11 to 13, 17 to 23)</li> </ol> |
| <b><u>Reference Book(s):</u></b><br><ol style="list-style-type: none"> <li>1. Sutherland, Stuart, Simon Davidmann, and Peter Flake, <i>SystemVerilog for Design: A guide to using SystemVerilog for hardware design and modelling</i>. Boston, MA: Springer US, 2006.</li> </ol>                                                                                                                    |
| <b><u>Web and Video link(s):</u></b><br><a href="http://tel.ac.in/courses/117103125">tel.ac.in/courses/117103125</a> ; NPTEL Video Lecture on VLSI Design Verification and testbyProf. Santhosh biswas, Prof. Jatindra Kumar Deka, Prof. Arnab Sarkar, IIT Guwahati.                                                                                                                                |

**Laboratory Manual:**

1. *System Verilog for Design and Verification Laboratory Manual*, Department of ECE, KITSW

| Course Articulation Matrix (CAM): |            |     |     | U24EC608 : SYSTEM VERILOG FOR DESIGN AND VERIFICATION LABORATORY |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                                                              | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC608.1 | 3   | 2   | 3                                                                | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO2                               | U24EC608.2 | 3   | 2   | 3                                                                | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO3                               | U24EC608.3 | 2   | 3   | 3                                                                | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| CO4                               | U24EC608.4 | 2   | 3   | 3                                                                | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| U24EC608                          |            | 2.5 | 2.5 | 3                                                                | 2.5 | 3   | 1   | 1   | 2.5 | 1.5 | 2    | 2.5  | 3    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                                                  |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                             |                 |                                                                                                  |                                                                                                                                                                                            |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to</i>                                                                                                                        | Relevant<br>SDG | SDG<br>Description                                                                               | Mapping Justification                                                                                                                                                                      |
| CO1                     | examine System Verilog language constructs and apply them in synthesizable RTL designs                                                                                      | SDG9            | Build infrastructure, promote inclusive and sustainable industrialization, and foster innovation | RTL design using SystemVerilog promotes innovation in semiconductor and digital infrastructure development, supporting industrial automation and sustainable technology growth.            |
| CO2                     | develop competence in structuring modular connectivity using interfaces, modports, and clocking blocks                                                                      | SDG9            | Industry, Innovation, and Infrastructure                                                         | Modular connectivity through interfaces and clocking blocks enhances design scalability and interoperability, contributing to reliable and innovative electronic infrastructure systems.   |
| CO3                     | construct reusable UVM testbench components and generate transaction level stimulus                                                                                         | SDG12           | Ensure sustainable consumption and production patterns                                           | Reusable verification components and transaction-level modeling reduce redundant design efforts and resource usage, promoting sustainable engineering practices in verification workflows. |
| CO4                     | demonstrate expertise in building coverage-driven verification environments by integrating constrained randomization, functional coverage models, and scoreboard techniques | SDG11           | Make cities and human settlements inclusive, safe, resilient, and sustainable                    | Coverage-driven verification ensures reliable and fault-tolerant electronic systems used in smart city applications, enhancing safety and sustainability in urban technology ecosystems.   |

## MINI PROJECT

|                                        |                |                    |             |
|----------------------------------------|----------------|--------------------|-------------|
| <b>Class:</b> B. Tech. VI – Semester   |                | <b>Branch:</b> ECE |             |
| <b>Course Code:</b>                    | U24EC610       | <b>Credits:</b>    | <b>1</b>    |
| <b>Hours/Week (L-T-P-E):</b>           | <b>0-0-2-1</b> | <b>CIE:</b>        | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | -              | <b>ESE:</b>        | -           |

### **Course Learning Outcomes (COs):**

*After completion of this course, the students should be able to,*

- CO1:** apply knowledge to practice to design & conduct experiments and utilize modern tools for developing working models / process / system leading to innovation & entrepreneurship
- CO2:** demonstrate the competencies to perform literature survey, identify gaps, analyze the problem and prepare a well-documented Mini project report
- CO3:** make an effective oral presentation through informative PPTs, showing knowledge on the subject & sensitivity towards social impact of the Mini project
- CO4:** write a “Mini project paper” in scientific journal style & format from the prepared Mini project report and create a video pitch on Mini project

*Student has to take up independent mini project on innovative ideas, innovative solutions to common problems using their knowledge relevant to courses offered in their program of study, which would supplement and complement the program assigned to each student.*

### **Guidelines:**

1. The HoD shall constitute a *Department Mini Project Evaluation Committee (DMPEC)*
2. *DMPEC* shall allot a faculty supervisor to each student for guiding on (i) selection of topic (ii) literature survey and work to be carried out (iii) preparing a report in proper format and (iv) effective mini project oral presentation
3. There shall be only continuous Internal Evaluation (CIE) for miniproject
4. The CIE for mini project is as follows:

| Assessment                                                        | Weightage   |
|-------------------------------------------------------------------|-------------|
| Mini Project Supervisor Assessment                                | 15%         |
| Working model / process / software package / system developed     | 20%         |
| Mini Project report                                               | 15%         |
| Mini Project paper                                                | 10%         |
| Video pitch                                                       | 10%         |
| <i>DMPEC Assessment: Oral presentation with PPT and viva-voce</i> | 15%         |
| SDG Alignment                                                     | 5%          |
| Research Alignment                                                | 10%         |
| <b>Total Weightage:</b>                                           | <b>100%</b> |

**Note:** It is mandatory for the student to appear for oral presentation and viva-voce to qualify for course evaluation

- (m) **Mini Project Topic:** The topic should be interesting and conducive to discussion. Topics may be found by looking through recent issues of peer reviewed Journals / Technical Magazines on the topics of potential interest

- (n) **Working Model:** Each student is requested to develop a working model / process / system on the chosen work and demonstrate before the *DMPEC* as per the dates specified by *DMPEC*
- (o) **Report:** Each student is required to submit a well-documented report on the chosen seminar topic as per the format specified by *DMPEC*
- (p) **Anti-Plagiarism Check:** The seminar report should clear plagiarism check as per the Anti-Plagiarism policy of the institute
- (q) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the *DMPEC* as per the schedule notified by the department
- (r) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her mini project. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include key points about his / her business idea / plan (*if any*) and social impact
- (s) The student has to register for the Mini project as supplementary examination in the following cases:
  - ix) he/she is absent for oral presentation and viva-voce
  - x) he/she fails to submit the report in prescribed format
  - xi) he/she fails to fulfill the requirements of Mini project evaluation as per specified guidelines
  - xii) The CoE shall send a list of students registered for supplementary to the HoD concerned
  - xiii) The DSEC, duly constituted by the HoD, shall conduct Mini project evaluation and send the award list to the CoE within the stipulated time

| Course Articulation Matrix (CAM): |            |          | U24EC610: Mini Project |     |          |          |     |      |      |      |      |      |      |      |
|-----------------------------------|------------|----------|------------------------|-----|----------|----------|-----|------|------|------|------|------|------|------|
| CO                                |            | PO1      | PO2                    | PO3 | PO4      | PO5      | PO6 | PO7  | PO8  | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC610.1 | 3        | 3                      | 2   | 3        | 3        | 2   | 1    | 2    | 1    | 2    | 2    | 2    | 1    |
| CO2                               | U24EC610.2 | 2        | 2                      | 2   | 3        | 2        | 1   | 1    | 1    | 2    | 1    | 3    | 1    | 1    |
| CO3                               | U24EC610.3 | 1        | 1                      | 1   | 1        | 2        | 2   | 1    | 2    | 3    | 1    | 2    | 1    | 1    |
| CO4                               | U24EC610.4 | 1        | 2                      | 1   | 2        | 2        | 1   | 2    | 1    | 3    | 1    | 2    | 1    | 1    |
| U24EC610                          |            | 1.7<br>5 | 2                      | 1.5 | 2.2<br>5 | 2.2<br>5 | 1.5 | 1.25 | 1.52 | 2.25 | 1.25 | 2.25 | 1.25 | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |          |                        |     |          |          |     |      |      |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                |              |                                         |                                                                                                                                                                                                                                                                                                                    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                                                                                                                | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                                                                                                                                                                              |
| CO1                     | apply knowledge to practice to design & conduct experiments and utilize modern tools for developing working models / process / system leading to innovation & entrepreneurship | SDG 9        | Industry, Innovation and Infrastructure | Mini projects involve the design and development of innovative ECE solutions such as IoT systems, embedded systems, communication networks, VLSI applications, and intelligent electronic devices. These activities promote technological innovation, entrepreneurship, and sustainable industrial infrastructure. |
| CO2                     | demonstrate the                                                                                                                                                                | SDG 4        | Quality                                 | Literature review, problem                                                                                                                                                                                                                                                                                         |

| CO-SDG Alignment Matrix |                                                                                                                                                        |              |                                        |                                                                                                                                                                                                                                                                    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                                                                                        | Relevant SDG | SDG Description                        | Mapping Justification                                                                                                                                                                                                                                              |
|                         | competencies to perform literature survey, identify gaps, analyze the problem and prepare a well-documented Mini project report                        |              | Education                              | analysis, technical documentation, and independent learning enhance research skills, critical thinking, and lifelong learning capabilities, thereby supporting quality technical education and knowledge creation.                                                 |
| CO3                     | make an effective oral presentation through informative PPTs, showing knowledge on the subject & sensitivity towards social impact of the Mini project | SDG 11       | Sustainable Cities and Communities     | Presentation and discussion of ECE-based solutions for smart cities, intelligent transportation systems, environmental monitoring, public safety, healthcare technologies, and digital connectivity contribute to sustainable and inclusive community development. |
| CO4                     | write a “Mini project paper” in scientific journal style & format from the prepared Mini project report and create a video pitch on Mini project       | SDG 12       | Responsible Consumption and Production | Scientific reporting and dissemination of project outcomes promote responsible innovation, ethical publication practices, efficient utilization of resources, and sustainable technology development.                                                              |

# 3<sup>rd</sup> Year

# Exit Courses

# Syllabus

### Bridge Courses for exit:

Successful completion of two subjects (6-Credits) during 2-months internship at the institute

(OR)

Successful completion of two suitable skill based courses (external) to qualify for Certification

### C. After Third Year: (B. Voc. in ECE)

- (i) The candidate should pass any two of the following additional courses (Degree Level) during the 2-Months internship at institute

| Exit Option to Qualify <b>B. Voc in ECE: Any Two (02) Courses during the 2 - Months internship</b> |          |             |                                                    |   |   |   |   |   |   |
|----------------------------------------------------------------------------------------------------|----------|-------------|----------------------------------------------------|---|---|---|---|---|---|
| S. No.                                                                                             | Category | Course Code | Course Title                                       | L | T | P | O | E | C |
| 1                                                                                                  | PCC      | U24EC610X   | Low Power VLSI                                     | 2 | - | 2 | - | 4 | 3 |
| 2                                                                                                  | PCC      | U24EC611X   | 5G and beyond 5G communications                    | 2 | - | 2 | - | 4 | 3 |
| 3                                                                                                  | PCC      | U24EC612X   | Real-Time Operating Systems (RTOS)                 | 2 | - | 2 | - | 4 | 3 |
| 4                                                                                                  | PCC      | U24EC613X   | Any other course approved by BoS Chair and Dean AA | 2 | - | 2 | - | 4 | 3 |

(OR)

- (ii) Any two suitable skill based courses to qualify for B. Voc in ECE Degree.

| Exit Option to Qualify <b>B. Voc in ECE: Any Two (02) Skill based Courses -:</b> |          |             |                                                                                                                                                                                                                                                                                                                            |   |   |   |   |   |   |
|----------------------------------------------------------------------------------|----------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|
| S. No.                                                                           | Category | Course Code | Course Title                                                                                                                                                                                                                                                                                                               | L | T | P | O | E | C |
| 1                                                                                | SEC      | U24SE610X   | Internet of Things (IOT) using Arduino <a href="https://www.nitttrchd.ac.in/imee/Labmanuals/manual%20Internet%20of%20Things%20I.pdf">https://www.nitttrchd.ac.in/imee/Labmanuals/manual%20Internet%20of%20Things%20I.pdf</a>                                                                                               | - | - | 6 | - | 6 | 3 |
| 2                                                                                | SEC      | U24SE611X   | Embedded System Design using ARM/Cortex Micro Controller <a href="https://www.nielit.gov.in/aurangabad/content/certificate-course-embedded-system-design-using-arm-cortex-microcontroller-0">https://www.nielit.gov.in/aurangabad/content/certificate-course-embedded-system-design-using-arm-cortex-microcontroller-0</a> | - | - | 6 | - | 6 | 3 |
| 3                                                                                | SEC      | U24SE612X   | Embedded System using 8051 and Arduino <a href="https://www.nielit.gov.in/sites/default/files/PDF/Training/EmbeddedSystemusing8051andArduino.pdf">https://www.nielit.gov.in/sites/default/files/PDF/Training/EmbeddedSystemusing8051andArduino.pdf</a>                                                                     | - | - | 6 | - | 6 | 3 |
| 4                                                                                | SEC      | U24SE613X   | Any other skill-based course approved by BoS Chair and Dean AA                                                                                                                                                                                                                                                             | - | - | 6 | - | 6 | 3 |

## LOW POWER VLSI

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                  |                    |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|--------------|
| <b>Class:</b> B.Tech. VI –Semester (Exit course)                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>U24EC610X</b>                                                                                                                                                 | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>2-1-0-3</b>                                                                                                                                                   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>32Hrs</b>                                                                                                                                                     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                  |                    |              |
| <b>CO1 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | illustrate the importance of low power design                                                                                                                    |                    |              |
| <b>CO2 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | identify the various source of power consumption inCMOS circuits                                                                                                 |                    |              |
| <b>CO3 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | develop the techniques to reduce the power dissipation in CMOS circuits                                                                                          |                    |              |
| <b>CO4 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | examine the circuit with probabilistic power technique                                                                                                           |                    |              |
| <b>CO5 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Design and simulate CMOS circuits to analyze dynamic and static power consumption under different operating conditions.                                          |                    |              |
| <b>CO6 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Estimate power dissipation and switching activity of CMOS circuits using SPICE simulation and probabilistic power analysis techniques.                           |                    |              |
| <b>CO7 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Implement and evaluate circuit- and logic-level low-power design techniques such as transistor sizing, logic optimization, voltage scaling, and energy recovery. |                    |              |
| <b>CO8 :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Design and compare leakage power reduction techniques including power gating, transistor stacking, VTCMOS, MTCMOS, and Dual-Vt CMOS circuits.                    |                    |              |
| <b>THEORY COMPONENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                  |                    | <b>9 Hrs</b> |
| Introduction: Motivation for low power VLSI design, Sources ofpower dissipation in Digital Integrated circuits. Emerging Lowpower approaches. Dynamic dissipation in CMOS, Effect of supplyvoltage and Threshold voltage, Impact of technology Scaling,Technology & Device innovation. Circuit Techniques for low powerdesign: techniques for leakage power reduction. Low-PowerDesign Through Voltage Scaling, Estimation and Optimization ofSwitching Activity, Reduction of Switched Capacitance |                                                                                                                                                                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                  |                    | <b>9 Hrs</b> |
| SPICE circuit simulation, gate level logic simulation, capacitive, power estimation, static state power, gate level capacitance, estimation, architecture level analysis. Probabilistic power, analysis: Random logic signals, probability & frequency,probabilistic power analysis techniques, signal entropy.                                                                                                                                                                                     |                                                                                                                                                                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                  |                    | <b>9 Hrs</b> |
| Low Power Circuit's: Transistor and gate sizing, networkrestructuring and Reorganization. Logic level: Gate reorganization,signal gating, logic encoding, state machine encoding, precomputation logic. Energy Recovery CMOS: energy dissipation intransistor channel using RC model, adiabatic dynamic logic circuit                                                                                                                                                                               |                                                                                                                                                                  |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                  |                    | <b>9 Hrs</b> |
| Leakage Power minimization Approaches: Variable-thresholdvoltage CMOS (VTCMOS) approach multi-threshold-voltage CMOS(MTCMOS) approach Power gating Transistor                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                  |                    |              |

stacking Dual-Vt assignment approach (DTCMOS)

### LABORATORY COMPONENT

#### List of Experiments

1. Design and simulate a CMOS inverter and measure dynamic and static power consumption under different input frequencies.
2. Analyze the effect of supply voltage (VDD) and threshold voltage (V<sub>th</sub>) scaling on propagation delay and power dissipation of CMOS circuits.
3. Estimate switching activity and power consumption of CMOS combinational circuits using SPICE simulation.
4. Perform probabilistic power analysis by evaluating signal probability, switching activity, and signal entropy.
5. Implement transistor sizing and gate resizing techniques and evaluate the Power-Delay Product (PDP).
6. Design low-power logic circuits using logic restructuring, signal gating, or precomputation techniques.
7. Design and simulate an adiabatic CMOS logic circuit and compare its energy consumption with conventional CMOS logic.
8. Implement and compare leakage reduction techniques such as MTCMOS, VTCMOS, power gating, transistor stacking, and Dual-Vt CMOS.

#### Text Book(s):

1. Kang, Sung Mo, and Yusuf Leblebici, *CMOS digital integrated circuits*, New York, NY, USA: MacGraw-Hill, 2003.
2. Weste, Neil HE, and Kamran Eshraghian, "Principles of CMOS VLSI design: a systems perspective," *NASA STI/Recon Technical Report A 85* (1985): 47028.

#### Reference Book(s):

1. Bellaouar, Abdellatif, and Mohamed Elmasry, *Low-power digital VLSI design: circuits and systems*, Springer Science & Business Media, 2012.

#### Web and Video link(s):

<https://nptel.ac.in/courses/106105034>; NPTEL Video Lecture on Low Power VLSI Circuits & Systems by Prof. Ajit Pal, IITKharagpur.

| Course Articulation Matrix (CAM): |             |     |     | U24EC610X : LOW POWER VLSI |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|----------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1 | PO2 | PO3                        | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC610X.1 | 3   | 2   | 3                          | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO2                               | U24EC610X.2 | 3   | 2   | 3                          | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO3                               | U24EC610X.3 | 2   | 3   | 3                          | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| CO4                               | U24EC610X.4 | 2   | 3   | 3                          | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| CO5                               | U24EC610X.5 | 3   | 2   | 3                          | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |

| Course Articulation Matrix (CAM): |             |     |     | U24EC610X : LOW POWER VLSI |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|----------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                        | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO6                               | U24EC610X.6 | 3   | 2   | 3                          | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO7                               | U24EC610X.7 | 2   | 3   | 3                          | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| CO8                               | U24EC610X.8 | 2   | 3   | 3                          | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| U24EC610X                         |             | 2.5 | 2.5 | 3                          | 2.5 | 3   | 1   | 1   | 2.5 | 1.5 | 2    | 2.5  | 3    | 2.5  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                            |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                        |                 |                                                                                                  |                                                                                                                                                                                            |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                | Relevant<br>SDG | SDG<br>Description                                                                               | Mapping Justification                                                                                                                                                                      |
| CO1                     | illustrate the importance of low power design                                                                                          | SDG9            | Build infrastructure, promote inclusive and sustainable industrialization, and foster innovation | RTL design using SystemVerilog promotes innovation in semiconductor and digital infrastructure development, supporting industrial automation and sustainable technology growth.            |
| CO2                     | identify the various source of power consumption in CMOS circuits                                                                      | SDG9            | Industry, Innovation, and Infrastructure                                                         | Modular connectivity through interfaces and clocking blocks enhances design scalability and interoperability, contributing to reliable and innovative electronic infrastructure systems.   |
| CO3                     | develop the techniques to reduce the power dissipation in CMOS circuits                                                                | SDG12           | Ensure sustainable consumption and production patterns                                           | Reusable verification components and transaction-level modeling reduce redundant design efforts and resource usage, promoting sustainable engineering practices in verification workflows. |
| CO4                     | examine the circuit with probabilistic power technique                                                                                 | SDG11           | Make cities and human settlements inclusive, safe, resilient, and sustainable                    | Coverage-driven verification ensures reliable and fault-tolerant electronic systems used in smart city applications, enhancing safety and sustainability in urban technology ecosystems.   |
| CO5                     | Design and simulate CMOS circuits to analyze dynamic and static power consumption under different operating conditions.                | SDG7            | Affordable and Clean Energy                                                                      | Simulation and analysis of power consumption facilitate the development of energy-efficient integrated circuits for modern electronic applications.                                        |
| CO6                     | Estimate power dissipation and switching activity of CMOS circuits using SPICE simulation and probabilistic power analysis techniques. | SDG9            | Industry, Innovation and Infrastructure                                                          | Power estimation techniques improve the design and optimization of semiconductor devices, enhancing innovation and industrial competitiveness.                                             |
| CO7                     | Implement and evaluate circuit- and logic-level                                                                                        | SDG12           | Responsible Consumption                                                                          | Implementing low-power techniques reduces energy waste and supports                                                                                                                        |

| CO-SDG Alignment Matrix |                                                                                                                                               |                 |                             |                                                                                                                                                                   |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                       | Relevant<br>SDG | SDG<br>Description          | Mapping Justification                                                                                                                                             |
|                         | low-power design techniques such as transistor sizing, logic optimization, voltage scaling, and energy recovery.                              |                 | and Production              | sustainable manufacturing and operation of VLSI systems.                                                                                                          |
| CO8                     | Design and compare leakage power reduction techniques including power gating, transistor stacking, VTCMOS, MTCMOS, and Dual-Vt CMOS circuits. | SDG7            | Affordable and Clean Energy | Leakage reduction techniques significantly lower standby power consumption, improving energy efficiency and extending the operational life of electronic devices. |

## 5G and BEYOND 5G WIRELESS COMMUNICATIONS

|                                                  |                  |                    |            |
|--------------------------------------------------|------------------|--------------------|------------|
| <b>Class:</b> B.Tech. VI –Semester (Exit course) |                  | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                              | <b>U24EC611X</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>                     | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b>           | <b>32Hrs</b>     | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1:** Explain the evolution, architecture, services and standards of 5G wireless communication systems.
- CO2:** Analyze advanced physical layer technologies such as OFDM, Massive MIMO, beamforming and mmWave communications used in 5G networks.
- CO3:** Apply multiple access techniques, cognitive radio and intelligent spectrum management methods in modern wireless communication systems.
- CO4:** Interpret Beyond-5G applications, AI/ML enabled wireless networks and emerging 6G technologies.
- CO5:** Model and analyze the physical layer performance of 5G wireless communication systems.
- CO6:** Simulate advanced transmission technologies including OFDM, Massive MIMO, beamforming, and mmWave communications.
- CO7:** Implement spectrum access and resource allocation techniques for efficient wireless communication systems.
- CO8:** Design and evaluate Beyond-5G applications using AI/ML-assisted communication and emerging 6G technologies.

### THEORY COMPONENT

|                                                                                                                                                                                                                                                                                                                                                               |             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                 | <b>4Hrs</b> |
| <b>Introduction to 5G Wireless Systems:</b> Evolution of wireless communication systems: 1G to 5G, Requirements and challenges of 5G networks, LTE, LTE-Advanced and LTE-A Pro overview, 5G NR architecture and protocol stack, Service categories: eMBB, URLLC and mMTC, Spectrum allocation and IMT-2020 standards, Small cells and heterogeneous networks. |             |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                | <b>4Hrs</b> |
| <b>Advanced PHY Layer Technologies:</b> OFDM fundamentals and limitations, Advanced waveforms: FBMC, GFDM and UFMC, Massive MIMO systems, Beamforming techniques, Hybrid beamforming, Millimeter-wave (mmWave) communications, 5G channel models, Carrier aggregation and bandwidth parts.                                                                    |             |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                               | <b>4Hrs</b> |
| <b>Multiple Access and Spectrum Management:</b> Non-Orthogonal Multiple Access (NOMA), SCMA, Power-domain NOMA, Resource allocation techniques, Interference management, Cognitive radio networks, Dynamic spectrum sharing, Spectrum sensing techniques.                                                                                                     |             |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                | <b>4Hrs</b> |
| <b>Beyond 5G and Emerging Technologies:</b> Device-to-Device (D2D) communication, Internet                                                                                                                                                                                                                                                                    |             |

of Things (IoT) in 5G, Vehicle-to-Everything (V2X) communication, UAV-assisted communication, Edge computing and network slicing, AI/ML in wireless communication, Reconfigurable Intelligent Surfaces (RIS), Introduction to 6G technologies, Security challenges in 5G/B5G systems.

#### **LABORATORY COMPONENT**

1. Simulation of OFDM transceiver for 5G NR and evaluation of BER performance under AWGN and multipath fading channels.
2. Design and simulation of Massive MIMO communication system and performance comparison with conventional MIMO.
3. Simulation of digital beamforming and hybrid beamforming techniques for mmWave communication systems.
4. Performance analysis of carrier aggregation and bandwidth allocation in 5G networks.
5. Implementation of Power-Domain NOMA with Successive Interference Cancellation (SIC) and comparison with OMA.
6. Simulation of cognitive radio spectrum sensing and dynamic spectrum access using energy detection techniques.
7. Simulation of Device-to-Device (D2D) communication or Vehicle-to-Everything (V2X) communication and evaluation of throughput and latency.
8. Mini project: Design and simulation of an AI-assisted or Beyond-5G wireless communication application (e.g., RIS-assisted communication, network slicing, edge computing, or UAV-assisted communication).

#### **Text Book(s):**

1. Dahlman E., Parkvall S., and Skold J., *5G NR: The Next Generation Wireless Access Technology*, 2nd ed., Academic Press, 2020.
2. Vaezi M., Ding Z., and Poor H. V., *Multiple Access Techniques for 5G Wireless Networks and Beyond*, Springer, 2019.

#### **Reference Book(s):**

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2005.
2. Andreas F. Molisch, *Wireless Communications: From Fundamentals to Beyond 5G*, 3rd ed., Wiley, 2022.
3. Mohammad A. Matin, *Spectrum Access and Management for Cognitive Radio Networks*, Springer, 2017.

#### **Web and Video link(s):**

1. <https://onlinecourses.nptel.ac.in/> NPTEL Video Lectures on Wireless Communication and 5G Technologies by IIT Professors.
2. <https://www.qualcomm.com/5g/what-is-5g> Qualcomm Tutorial on 5G Fundamentals, Architecture and Applications.
3. <https://www.mathworks.com/videos/series/understanding-the-5g-nr-standard.html> MATLAB and Simulink Video Series on 5G NR Standard and PHY Layer Technologies.
4. <https://www.3gpp.org/> Official 3GPP Website for 5G NR Standards and Releases.

| Course Articulation Matrix (CAM): |             |      |      | U24EC611X : 5G AND BEYOND WIRELESS COMMUNICATIONS |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|------|---------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2  | PO3                                               | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC611X.1 | 2    | 2    | 1                                                 | -   | -   | -   | -   | -   | 1   | -    | 2    | 2    | -    |
| CO2                               | U24EC611X.2 | 3    | 2    | 2                                                 | 2   | 1   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO3                               | U24EC611X.3 | 2    | 3    | 2                                                 | 2   | 1   | -   | -   | -   | -   | -    | 2    | -    | 3    |
| CO4                               | U24EC611X.4 | 2    | 2    | 2                                                 | -   | 1   | -   | 1   | -   | -   | -    | 3    | -    | 3    |
| CO5                               | U24EC611X.5 | 2    | 2    | 1                                                 | -   | -   | -   | -   | -   | 1   | -    | 2    | 2    | -    |
| CO6                               | U24EC611X.6 | 3    | 2    | 2                                                 | 2   | 1   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO7                               | U24EC611X.7 | 2    | 3    | 2                                                 | 2   | 1   | -   | -   | -   | -   | -    | 2    | -    | 3    |
| CO8                               | U24EC611X.8 | 2    | 2    | 2                                                 | -   | 1   | -   | 1   | -   | -   | -    | 3    | -    | 3    |
| U24EC611X                         |             | 2.25 | 2.25 | 1.75                                              | 2   | 1   | -   | 1   | -   | 1   | -    | 2.33 | 2.5  | 3    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |      |                                                   |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                         |                 |                                         |                                                                                                                                                        |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                 | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                  |
| CO1                     | Explain the evolution, architecture, services and standards of 5G wireless communication systems.                                       | SDG9            | Industry, Innovation and Infrastructure | 5G wireless communication technologies support modern digital infrastructure, smart connectivity and innovation in communication systems.              |
| CO2                     | Analyze advanced physical layer technologies such as OFDM, Massive MIMO, beamforming and mmWave communications used in 5G networks.     | SDG9            | Industry, Innovation and Infrastructure | Advanced PHY layer technologies improve spectral efficiency, network capacity and high-speed communication infrastructure for future wireless systems. |
| CO3                     | Apply multiple access techniques, cognitive radio and intelligent spectrum management methods in modern wireless communication systems. | SDG7            | Affordable and Clean Energy             | Efficient spectrum utilization and intelligent resource allocation reduce energy consumption and improve sustainable wireless communication systems.   |
| CO4                     | Interpret Beyond-5G applications, AI/ML enabled wireless networks and emerging 6G technologies.                                         | SDG11           | Sustainable Cities and Communities      | AI-enabled 5G/6G technologies support smart cities, intelligent transportation, IoT applications and sustainable urban communication infrastructure.   |
| CO5                     | Model and analyze the physical layer performance of 5G wireless communication systems through simulation.                               | SDG9            | Industry, Innovation and Infrastructure | Simulation of 5G physical layer technologies facilitates the design and optimization of robust and innovative communication infrastructure.            |
| CO6                     | Simulate advanced transmission technologies including OFDM,                                                                             | SDG9            | Industry, Innovation and Infrastructure | Practical implementation of advanced transmission techniques improves communication efficiency and supports innovation in next-                        |

| CO-SDG Alignment Matrix |                                                                                                             |                 |                                    |                                                                                                                                                          |
|-------------------------|-------------------------------------------------------------------------------------------------------------|-----------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                     | Relevant<br>SDG | SDG<br>Description                 | Mapping Justification                                                                                                                                    |
|                         | Massive MIMO, beamforming, and mmWave communications.                                                       |                 |                                    | generation wireless systems.                                                                                                                             |
| CO7                     | Implement spectrum access and resource allocation techniques for efficient wireless communication systems.  | SDG7            | Affordable and Clean Energy        | Efficient spectrum management reduces transmission overhead, improves spectral efficiency, and promotes energy-efficient wireless network operation.     |
| CO8                     | Design and evaluate Beyond-5G applications using AI/ML-assisted communication and emerging 6G technologies. | SDG11           | Sustainable Cities and Communities | AI-enabled and 6G communication solutions support smart infrastructure, intelligent mobility, and sustainable digital ecosystems for future communities. |

## REAL TIME OPERATING SYSTEMS

|                                                  |                  |                    |            |
|--------------------------------------------------|------------------|--------------------|------------|
| <b>Class:</b> B.Tech. VI –Semester (Exit course) |                  | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                              | <b>U24EC612X</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>                     | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b>           | <b>32Hrs</b>     | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** Understand the fundamental concepts of operating systems, including OS structure, kernel functions, UNIX/LINUX commands, file handling, and process management system calls for developing efficient system-level applications.
- CO2 :** Explain the concepts of Real Time Operating Systems (RTOS), including task scheduling, synchronization, semaphores, message queues, and inter-process communication for designing real-time and concurrent systems.
- CO3 :** Understand the concepts of RTOS objects, inter-process communication mechanisms, signals, pipes, event registers, and I/O subsystem operations for developing efficient system-level and embedded applications.
- CO4 :** Demonstrate understanding of exception handling, interrupt processing, timer management, and RTOS architectures to develop and analyze efficient real-time and embedded system applications.
- CO5:** Develop UNIX/Linux programs using shell commands and system calls for file handling, process creation, and process management.
- CO6:** Implement CPU scheduling algorithms and RTOS task management techniques using synchronization mechanisms such as semaphores, mutexes, and message queues.
- CO7:** Design and implement inter-process communication (IPC) mechanisms using pipes, signals, shared memory, and related RTOS objects for concurrent applications.
- CO8:** Develop and analyze real-time applications using interrupt handling, timer services, and RTOS platforms to evaluate system performance and reliability.

### THEORY COMPONENT

| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                   | 4Hrs |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| <b>Introduction to Operating Systems:</b> Operating system concepts, Fundamental and Functions, Evolution of Operating Systems, Operation, Structure and Architecture of Computer Systems, OS Structure and Operations, Kernel Data Structures.<br><br>Introduction to UNIX/LINUX, Overview of Commands, File I/O,( open, create, close, lseek, read, write), Process Control ( fork, vfork, exit, wait, waitpid, exec). |      |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                  | 4Hrs |
| <b>Real Time Operating Systems:</b> Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use.                                                                    |      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>4Hrs</b> |
| Objects, Services and I/O: Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>4Hrs</b> |
| Exceptions, Interrupts and Timers: Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |
| Case Studies of RTOS: RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, and Tiny OS.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |
| <b>LABORATORY COMPONENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |
| <b>List of Lab Experiments:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |
| <ol style="list-style-type: none"><li>1. Study and execute basic Linux commands for file and directory operations, permissions, text processing, and archiving.</li><li>2. Implement UNIX/Linux System Calls for File Management</li><li>3. Implement Process Creation and Management Using System Calls</li><li>4. Implement and compare CPU scheduling algorithms such as FCFS, SJF, Priority Scheduling, and Round Robin based on waiting time and turnaround time.</li><li>5. Create multiple tasks and implement synchronization using semaphores, mutexes, and message queues in an RTOS environment (FreeRTOS/RTLinux).</li><li>6. Develop applications using pipes, signals, shared memory, and message queues for communication between processes.</li><li>7. Implement timer-based tasks, interrupt service routines (ISR), and software timers to study real-time event handling.</li><li>8. Install and analyze an RTOS (FreeRTOS/RTLinux/Embedded Linux), evaluate task scheduling, context switching, IPC mechanisms, and compare its performance with a general-purpose operating system.</li></ol> |             |
| <b><u>TextBook(s):</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |
| <ol style="list-style-type: none"><li>1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, Tenth edition, Wiley, 2018.</li><li>2. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011.</li></ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |
| <b><u>Reference Book(s):</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |
| <ol style="list-style-type: none"><li>1. Advanced UNIX Programming, Richard Stevens</li><li>2. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh</li><li>3. K. C. Wang, "Embedded and Real time operating systems", Springer, 2017.</li><li>4. Jonathan Valvano, "Real time operating systems for ARM Cortex-M Microcontrollers, Embedded systems - Volume 3", ARM Educational Media, 2017.</li></ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |
| <b><u>Web and Video link(s):</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |
| <a href="https://www.youtube.com/watch?v=LvaU7Vokg9E&amp;t=1s">ps://www.youtube.com/watch?v=LvaU7Vokg9E&amp;t=1s</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |

| Course Articulation Matrix (CAM): |             |     |     | U24EC612X :REAL TIME OPERATING SYSTEMS |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|----------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                                    | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC612X.1 | 1   | 2   | 2                                      | 1   | -   | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC612X.2 | 2   | 2   | 2                                      | 2   | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |

| Course Articulation Matrix (CAM): |             |      |     | U24EC612X :REAL TIME OPERATING SYSTEMS |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|-----|----------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1  | PO2 | PO3                                    | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO3                               | U24EC612X.3 | 2    | 2   | 2                                      | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC612X.4 | 2    | 2   | 3                                      | 3    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO5                               | U24EC612X.5 | 1    | 2   | 2                                      | 1    | -   | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO6                               | U24EC612X.6 | 2    | 2   | 2                                      | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO7                               | U24EC612X.7 | 2    | 2   | 2                                      | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO8                               | U24EC612X.8 | 2    | 2   | 3                                      | 3    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| U24EC612X                         |             | 1.75 | 2   | 2.25                                   | 1.75 | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |     |                                        |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                                                 |                                                 |                                                                                                             |                                                                                                                                                                                                                                                                                           |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                                                                         | Relevant<br>SDG                                 | SDG<br>Description                                                                                          | Mapping Justification                                                                                                                                                                                                                                                                     |
| CO1                     | Understand the fundamental concepts of operating systems, including OS structure, kernel functions, UNIX/LINUX commands, file handling, and process management system calls for developing efficient system-level applications. | SDG 9 – Industry, Innovation and Infrastructure | Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. | provides fundamental knowledge of operating systems and system programming concepts that form the backbone of modern computing infrastructure. Understanding UNIX/LINUX systems, file management, and process control helps students build efficient and innovative software systems.     |
| CO2                     | Explain the concepts of Real Time Operating Systems (RTOS), including task scheduling, synchronization, semaphores, message queues, and inter-process communication for designing real-time and concurrent systems.             | SDG 9 – Industry, Innovation and Infrastructure | Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation  | develops knowledge of RTOS concepts used in embedded systems, automation, robotics, healthcare devices, and industrial control systems. Understanding scheduling, synchronization, and communication mechanisms enables students to design reliable and efficient real-time applications. |
| CO3                     | Understand the concepts of RTOS objects, inter-process communication mechanisms, signals, pipes, event registers, and I/O subsystem operations for developing efficient system-level and embedded applications.                 | SDG 4 – Quality Education                       | Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.       | enhances students' technical competencies in system-level programming and real-time communication mechanisms, promoting advanced computing skills and lifelong learning necessary for modern engineering and technology education.                                                        |
| CO4                     | Demonstrate understanding of exception handling, interrupt processing, timer management, and RTOS architectures to develop and analyze efficient real-                                                                          | SDG 8 – Decent Work and Economic Growth         | Promote sustained, inclusive, and sustainable economic growth, full and productive                          | equips students with industry-relevant skills in real-time computing and embedded operating systems, enhancing employability and preparing them for careers in automation, IoT, robotics, and software industries that contribute                                                         |

| CO-SDG Alignment Matrix |                                                                                                                                                              |                 |                                         |                                                                                                                                                             |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                      | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                       |
|                         | time and embedded system applications.                                                                                                                       |                 | employment, and decent work for all.    | to sustainable economic growth.                                                                                                                             |
| CO5                     | Develop UNIX/Linux programs using shell commands and system calls for file handling, process creation, and process management.                               | SDG 9           | Industry, Innovation and Infrastructure | Practical exposure to Linux system programming develops skills required for building reliable operating systems and industrial software infrastructure.     |
| CO6                     | Implement CPU scheduling algorithms and RTOS task management techniques using synchronization mechanisms such as semaphores, mutexes, and message queues.    | SDG 9           | Industry, Innovation and Infrastructure | RTOS scheduling and synchronization are fundamental to embedded systems, industrial automation, robotics, and communication infrastructure.                 |
| CO7                     | Design and implement inter-process communication (IPC) mechanisms using pipes, signals, shared memory, and related RTOS objects for concurrent applications. | SDG 12          | Responsible Consumption and Production  | Efficient IPC and resource-sharing techniques optimize CPU and memory utilization, promoting sustainable and resource-efficient software development.       |
| CO8                     | Develop and analyze real-time applications using interrupt handling, timer services, and RTOS platforms to evaluate system performance and reliability.      | SDG 11          | Sustainable Cities and Communities      | Real-time embedded applications support smart transportation, healthcare, industrial IoT, and smart city systems requiring dependable and timely operation. |

# 7<sup>th</sup> Semester Syllabus

## VII SEMESTER

| Sl. No.                                                                                                                                                  | Category | Course Code | Course Title                                       | Lectures / week |   |    |    | Credits |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|----------------------------------------------------|-----------------|---|----|----|---------|
|                                                                                                                                                          |          |             |                                                    | L               | T | P  | E  | C       |
| 1                                                                                                                                                        | OEC      | U24OE701    | Open Elective - III                                | 2               | 1 | -  | 3  | 3       |
| 2                                                                                                                                                        | PEC      | U24EC702    | Program Elective - II/ MOOCs-II                    | 2               | 1 | -  | 3  | 3       |
| 3                                                                                                                                                        | PCC      | U24EC703    | Real Time Operating Systems                        | 2               | 1 | -  | 3  | 3       |
| 4                                                                                                                                                        | PCC      | U24EC704    | Internet of Things                                 | 2               | 1 | -  | 3  | 3       |
| 5                                                                                                                                                        | PCC      | U24EC705    | Computer Vision and Image Processing               | 2               | 1 | -  | 3  | 3       |
| 6                                                                                                                                                        | PCC      | U24EC706    | Internet of Things & Sensor Laboratory             | -               | - | 2  | 2  | 1       |
| 7                                                                                                                                                        | ELC      | U24EC707    | Internship Evaluation*                             | -               | - | 2  | 2  | 1       |
| 8                                                                                                                                                        | ELC      | U24EC708    | Major Project, Phase-1 / Industrial Internship - 1 | -               | - | 8  | 8  | 4       |
| Total:                                                                                                                                                   |          |             |                                                    | 10              | 5 | 12 | 27 | 21      |
| Additional Learning@:Maximum credits allowed for Honours/Minor                                                                                           |          |             |                                                    | -               | - | -  | -  | 4       |
| Total credits for Honours/Minor students:                                                                                                                |          |             |                                                    | -               | - | -  | -  | 25      |
| Summer/ Inter-Sem Mandatory Bridge Courses: 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet) |          |             |                                                    | -               | - | -  | -  | -       |

**#MULTIDISCIPLINARY OPEN ELECTIVES:** Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

| Open Elective - III |             |                                                        |
|---------------------|-------------|--------------------------------------------------------|
| S. No.              | Course Code | Course Title                                           |
| 1.                  | U24OE701    | Sustainable Waste Management and Circular Economy [CE] |
| 2.                  | U24OE709    | Sustainable AI [CSE(AI&ML)]                            |
| 3.                  | U24OE716    | Cyber Physical Systems [CSE(Networks)]                 |
| 4.                  | U24OE718    | Software Quality Assurance and Testing[CSE]            |
| 5.                  | U24OE727    | Any other course approved by BoS Chair and Dean AA     |

| <b>SUSTAINABLE WASTE MANAGEMENT AND CIRCULAR ECONOMY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |                   |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------|-------------|
| <b>Class:</b> B.Tech.VII –Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          | <b>Branch:</b> CE |             |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | U24OE701 | <b>Credits:</b>   | 3           |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 2-1-0-3  | <b>CIE:</b>       | 60%         |
| <b>Total No of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 36Hrs    | <b>ESE:</b>       | 40%         |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the student should be able to,</i><br><b>CO1:</b> appraise the concept of waste management<br><b>CO2:</b> analyze activities associated with the management of hazardous wastes<br><b>CO3:</b> apply the concept of circular economy and conduct relevant research<br><b>CO4:</b> create business models for sustainable development using complex aspects of circular economy.                                                                                                                                                                                                                                                                                                                                                                 |          |                   |             |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |                   | <b>9Hrs</b> |
| <b>Waste management:</b> Introduction, context and overview of waste management, waste landscape in India, hierarchy of waste management, sources of waste and waste streams, challenges and opportunities in waste management.<br><br><b>Strategies for Waste management:</b> Need for National Waste Management Strategies (NWMS), Concepts and principles, objectives, goals and targets, policy tools for waste management, process of developing NWMS, implementation of NWMS, roles and responsibilities of various sectors, supporting initiatives of public and private domains, international recommendations and mandates.                                                                                                                                                                                         |          |                   |             |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |                   | <b>9Hrs</b> |
| <b>Elements of Hazardous waste management:</b> Hazardous waste definition, sources, identification and classification, Collection, handling, storage and transport, Hazardous waste management rules and regulations, treatment technologies, Hazardous waste disposal, Hazardous waste landfills- Site selections, design and operation. Hazardous waste reduction, recycling and reuse, remediation of hazardous waste contaminated sites.<br><br><b>Management of different Hazardous waste:</b><br>Sources, Production, collection, segregation, treatment and disposal of hazardous wastes - plastic waste -biomedical waste- E-waste-nuclear waste- Global and Indian Context, Hazardous Waste Management Practices – Health and environmental effects, recycling, energy production, landfilling, other applications. |          |                   |             |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |                   | <b>9Hrs</b> |

**Introduction to Circular Economy:** Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy.

**Characteristics of Circular Economy:** Material recovery, waste reduction, reducing negative externalities, explaining butterfly diagram, concept of loops.

#### UNIT-IV

9Hrs

**Circular design, innovation and Assessment:** Zero waste-Waste Management in context of Circular Economy, Circular design, Research and innovation, Life Cycle Assessment (LCA), Circular Business Models

**Case Studies and Legal policy framework** Business models, Solid Waste Management / Wastewater, Plastics: A case study, EPR: polluters pay principle, Industrial symbiosis/ Eco-parks, Role of governments and networks, Sharing best practices, Universal circular economy policy goals, India and CE strategy, ESG

#### Text Book(s):

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-United Nations Institute for Training and Research-2013-ISBN: 978-92-807-3333-4
2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition.
3. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen Hand Vigil SA, McGraw Hill Education, 2014, Indian Edition

#### Reference Book(s):

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-United Nations Institute for Training and Research-2013-ISBN: 978-92-807-3333-4
2. National Waste Management Strategy 2020- Minister of Forestry, Fisheries and the Environment, Republic of South Africa
3. *Circular Economy: A Credit Point Course*, Proposed by International Council for Circular Economy (ICCE) New Delhi, In Collaboration with All India Council for Technical Education (AICTE) New Delhi.
4. *The Circular Economy A User's Guide* Walter R Stahel Routledge; 1st Edition (24 June 2019)
5. *Circular Economy: (Re)Emerging Movement* Shalini Goyal Bhalla InVincible Publisher
6. *The Circular Economy Handbook: Realizing The Circular Advantage* Peter Lacy, Jessica Long, Wesley Spindler Palgrave Macmillan UK
7. *Waste to Wealth: The Circular Economy Advantage* Peter Lacy, Jakob Rutqvist Palgrave Macmillan

**WebandVideolink(s):**

1. <https://nptel.ac.in/courses/105105160>; NPTEL Course on Integrated Waste Management for a Smart City (Municipal Solid Waste, C&D Waste, E-Waste, NWMS, Waste Hierarchy, Policy Tools, Composting, Landfilling) by Prof. Brajesh Kumar Dubey, IIT Kharagpur.
2. <https://nptel.ac.in/courses/105105169>; NPTEL Course on Electronic Waste Management – Issues and Challenges (E-Waste Generation, Biomedical, Plastic & Hazardous Waste Rules, Recycling, Landfill Design, Remediation) by Prof. Brajesh Kumar Dubey, IIT Kharagpur.
3. <https://nptel.ac.in/courses/105103205>; NPTEL Course on Municipal Solid Waste Management (Circular Economy Principles, Material Recovery, LCA, Butterfly Diagram, Waste Reduction & Loop Strategies) by IIT Guwahati.
4. [https://onlinecourses.nptel.ac.in/noc25\\_ce122/preview](https://onlinecourses.nptel.ac.in/noc25_ce122/preview); NPTEL Course on Integrated Waste Management for a Smart City – 2025 Edition (Circular Business Models, EPR, Industrial Symbiosis, ESG, Zero-Waste Strategies, India CE Policy Framework) by Prof. Brajesh Kumar Dubey, IIT Kharagpur.

| Course Articulation Matrix (CAM): |            |     |      | U24OE701:<br>SUSTAINABLE WASTE MANAGEMENT AND CIRCULAR ECONOMY |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|------|----------------------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2  | PO3                                                            | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24OE701.1 | 2   | 1    | 1                                                              | 1   | -   | 1   | 1   | 1   | -   | 1    | 1    | -    | 1    |
| CO2                               | U24OE701.2 | 2   | 1    | 1                                                              | 1   | -   | 1   | 1   | 1   | 1   | 1    | 1    | -    | 1    |
| CO3                               | U24OE701.3 | 2   | 2    | 2                                                              | 1   | -   | 1   | 1   | 1   | 1   | 1    | 1    | -    | 1    |
| CO4                               | U24OE701.4 | 2   | 1    | 1                                                              | 1   | 2   | 1   | 1   | 1   | 1   | 1    | 1    | -    | 1    |
| U24OE701                          |            | 2   | 1.25 | 1.25                                                           | 1   | 2   | 1   | 1   | 1   | 1   | 1    | 1    | -    | 1    |
| 3-HIGH, 2-MEDIUM, 1-LOW           |            |     |      |                                                                |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                       |              |                                        |                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------|-----------------------------------------------------------------------|--------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br>The students should be able to...                     | Relevant SDG | SDG Description                        | Mapping Justification                                                                                                                                                                                                                                                                                                                             |
| CO1                     | appraise the concept of waste management                              | SDG12        | Responsible Consumption and Production | Appraising the waste management hierarchy, National Waste Management Strategies (NWMS), and policy tools for controlling waste streams directly promotes responsible consumption, sustainable production patterns, and significant reduction of waste generation across municipal, industrial, and hazardous waste sectors.                       |
| CO2                     | analyze activities associated with the management of hazardous wastes | SDG11        | Sustainable Cities and Communities     | Analyzing collection, handling, treatment, landfill design, and regulatory compliance for hazardous wastes – including plastic, biomedical, e-waste, and nuclear waste – safeguards human health and environmental quality, contributing to the development of safe, resilient, and environmentally sustainable urban and industrial communities. |

|     |                                                                                               |      |                                         |                                                                                                                                                                                                                                                                                                                                                    |
|-----|-----------------------------------------------------------------------------------------------|------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO3 | apply the concept of circular economy and conduct relevant research                           | SDG9 | Industry, Innovation and Infrastructure | Applying circular economy principles – material recovery, waste reduction, LCA, butterfly diagram, and loop strategies – and conducting innovation-driven research fosters sustainable industrial practices that decouple economic growth from resource depletion, supporting resilient and environmentally responsible industrial infrastructure. |
| CO4 | Create business models for sustainable development using complex aspects of circular economy. | SDG9 | Industry, Innovation and Infrastructure | Creating circular business models – incorporating EPR, industrial symbiosis, eco-parks, zero-waste strategies, ESG frameworks, and India-specific CE policy goals – drives innovation-led, resource-efficient industry and contributes to inclusive, sustainable economic growth aligned with SDG 9 and the global circular economy agenda.        |

| SUSTAINABLE AI                                                                                                                                                                                                                                   |          |                   |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------|-------|
| Class: B. Tech. VII – Semester                                                                                                                                                                                                                   |          | Branch:CSE(AI&ML) |       |
| Course Code:                                                                                                                                                                                                                                     | U24OE709 | Credits:          | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                            | 2-1-0-3  | CIE:              | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                  | 36Hrs    | ESE:              | 40%   |
| Course Outcomes (COs)                                                                                                                                                                                                                            |          |                   |       |
| After completion of this course, the students should be able to,                                                                                                                                                                                 |          |                   |       |
| CO1: explain Sustainability &AI, Resource Efficiency and consumption, Climate Awareness                                                                                                                                                          |          |                   |       |
| CO2: analyze energy consumption and environmental impacts of AI models.                                                                                                                                                                          |          |                   |       |
| CO3: apply optimization techniques for resource-efficient AI deployment.                                                                                                                                                                         |          |                   |       |
| CO4: Evaluate sustainable AI applications and emerging trends across various domains.                                                                                                                                                            |          |                   |       |
| UNIT-I                                                                                                                                                                                                                                           |          |                   | 9 Hrs |
| Sustainability and Artificial Intelligence:Scope of Sustainability, Artificial Intelligence-The New Electricity?, Sustainability × AI, A Green Path to Sustainable AI.                                                                           |          |                   |       |
| Under the Hood of Generative AI: Representation Learning, Learning Representations to GenAI, Building GenAI.                                                                                                                                     |          |                   |       |
| Quantifying the Efficiency of Deep Learning:AI Waste, Resource Consumption of Deep Learning, Resource Efficiency and Climate Awareness, Quantifying Resource Consumption of AI, Carbon Footprint of AI Models, Efficiency Quantified.            |          |                   |       |
| UNIT-II                                                                                                                                                                                                                                          |          |                   | 9 Hrs |
| Data Parsimony: The Cost of Data, Dataset Curation, Active Learning for Dataset Creation, Learning with Pruned Datasets, Learning with Compressed Data, Data and Dataset Compressed.                                                             |          |                   |       |
| Automating Model Selection:Hyperparameter Optimization, Neural Architecture Search, Model Selection in the Era of Foundational Models, Model Selection Automated.                                                                                |          |                   |       |
| UNIT-III                                                                                                                                                                                                                                         |          |                   | 9 Hrs |
| Training Efficiency:Training Costs of AI Models, Transfer Learning, Training Compressed Neural Networks, Quantization, Efficient Training Achieved.                                                                                              |          |                   |       |
| Lean Inference:,Lifetime Cost of an AI Model, Achieving Lean Inference, Deploying Models, Inference is Lean.                                                                                                                                     |          |                   |       |
| Hardware Considerations:Environmental Cost of AI Hardware, Hardware Scaling Laws of AI, The Alchemy of Creating AI, Improving the Resource Efficiency of AI Hardware, Hardware Optimized.                                                        |          |                   |       |
| UNIT-IV                                                                                                                                                                                                                                          |          |                   | 9 Hrs |
| A Recipe for Sustainable AI:Technical Debt of Machine Learning, Environmental Debt of AI, Operationalizing Sustainable AI, Green MLOps in Practice, Sustainable AI Operationalized.                                                              |          |                   |       |
| Toward Sustainable AI:Efficiency Is Not Enough, The Way Forward, Impact of Sustainable AI.                                                                                                                                                       |          |                   |       |
| TextBook(s):                                                                                                                                                                                                                                     |          |                   |       |
| 1. Raghavendra Selvan,“Sustainable AI Tools for Moving Toward Green AI”,First Edition, O’Reilly Media, October 2025.                                                                                                                             |          |                   |       |
| Reference Book(s):                                                                                                                                                                                                                               |          |                   |       |
| 1. Aboul Ella Hassanien, Roheet Bhatnagar, and Ashraf, <i>Artificial Intelligence for Sustainable Development: Theory, Practice and Future Applications</i> , Springer Nature, Computational Intelligence, Volume 912, September 2021,New DELHI. |          |                   |       |
| 2. Mohammad Dastbaz, Colin Pattinson, Babak Akhgar , <i>Green Information TechnologyA Sustainable Approach</i> , Morgan Kaufmann1st Edition, March 3, 2015                                                                                       |          |                   |       |

| Course Articulation Matrix (CAM): U24OE709: SUSTAINABLE AI |     |     |     |     |     |     |     |     |     |      |      |      |      |
|------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| Course Outcomes                                            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 U24OE709.1                                             | 1   | 2   | 1   | 1   | 1   | -   | 1   | 1   | 1   | 1    | 1    | -    | 1    |

|                               |            |   |   |     |     |   |   |   |   |     |   |   |   |   |
|-------------------------------|------------|---|---|-----|-----|---|---|---|---|-----|---|---|---|---|
| CO2                           | U24OE709.2 | 1 | 2 | 2   | 2   | 1 | - | 1 | 1 | 1   | 1 | 1 | - | 1 |
| CO3                           | U24OE709.3 | 1 | 2 | 2   | 2   | 1 | - | 1 | 1 | 2   | 1 | 1 | - | 1 |
| CO4                           | U24OE709.4 | 1 | 2 | 1   | 1   | 1 | - | 1 | 1 | 2   | 1 | 1 | - | 1 |
| U24OE709                      |            | 1 | 2 | 1.5 | 1.5 | 1 | - | 1 | 1 | 1.5 | 1 | 1 | - | 1 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW |            |   |   |     |     |   |   |   |   |     |   |   |   |   |

| CO-SDG Alignment Matrix |                                                                                     |                 |                                                         |                                                                                                                                                                    |
|-------------------------|-------------------------------------------------------------------------------------|-----------------|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                             | Relevant<br>SDG | SDG<br>Description                                      | Mapping Justification                                                                                                                                              |
| CO1                     | explain Sustainability & AI, Resource Efficiency and consumption, Climate Awareness | SDG 13          | Climate Action                                          | Introduces the principles of sustainable AI and emphasizes climate awareness and reducing the environmental impact of AI technologies.                             |
| CO2                     | analyze energy consumption and environmental impacts of AI models.                  | SDG 12          | Responsible Consumption and Production                  | Focuses on efficient utilization of computational resources, minimizing energy consumption, and promoting environmentally responsible AI practices.                |
| CO3                     | apply optimization techniques for resource-efficient AI deployment.                 | SDG 9           | Industry, Innovation and Infrastructure                 | Encourages the development of innovative, efficient, and sustainable AI models and infrastructure through optimization and efficient deployment techniques.        |
| CO4                     | Evaluate sustainable AI applications and emerging trends across various domains.    | SDG 9           | Industry, Innovation and Infrastructure; Climate Action | Assesses sustainable AI frameworks and deployment strategies that foster innovative technologies while supporting environmental sustainability and climate action. |

| CYBER PHYSICAL SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |                |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------|-------|
| Class: B. Tech. VII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          | Branch:CSE (N) |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | U24OE716 | Credits:       | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 2-1-0-3  | CIE:           | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 36Hrs    | ESE:           | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |                |       |
| <b>CO1 :</b> elaborate Cyber Physical Systems and its applications<br><b>CO2 :</b> analyze the safety requirements of Cyber Physical Systems and its models<br><b>CO3 :</b> analyze the Asynchronous design primitives in Cyber Physical Systems<br><b>CO4 :</b> analyze the applications of Cyber Physical Systems and apply the techniques to ensure security in CPS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |                |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |                | 9 Hrs |
| <b>Cyber-Physical System (CPS):</b> Introduction, Emergence of CPS, CPS drivers, Key features of CPS – Reactive computation, Concurrency, Feedback control of the physical world, Real time computation, Safety critical application, Overview – Formal models, Specification and analysis, Model based design and case studies.<br><br><b>Synchronous Model:</b> Reactive components – Variables, Valuations, Expressions, Input, Output, States, Initialization, Update, Executions, Extended state machines, Properties of components – Finite state, Combinational, Event triggered, Non deterministic, Input enabled components, Task graphs and await dependencies, Composing components – Block diagrams, Input/output variable renaming, Parallel composition, Output hiding, Synchronous designs – Synchronous circuits, Cruise control System, Synchronous networks. |          |                |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |                | 9 Hrs |
| <b>Safety requirements:</b> Safety specifications – Invariants of transition systems, Role of requirements in system design, Safety monitors, verifying invariants – Providing invariants, Automated invariant verification, Simulation based analysis, Enumerative search, Symbolic search.<br><br><b>Asynchronous Model:</b> Asynchronous processes – States, Inputs, Outputs and Internal actions, Executions, Extended state machines, Operations on processes, Safety requirements.                                                                                                                                                                                                                                                                                                                                                                                       |          |                |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                | 9 Hrs |
| <b>Asynchronous Design Primitives:</b> Blocking and non-blocking synchronization, Deadlocks, Shared memory, Fairness assumptions, Asynchronous coordination protocols – Leader election, Reliable transmission, Wait free consensus, Dynamical systems – Continuous time models, Linear systems, Design controllers, Analysis techniques, Time model –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |                |       |

Timed processes, Timing based protocol, Hybrid systems – Hybrid dynamical models, Designing hybrid systems.

#### UNIT-IV

9 Hrs

**Security of Cyber-Physical Systems:** Introduction, Basic techniques, Cyber security requirements, Attack model, Cyber and physical consequences, Counter measures, Advanced techniques, System theoretic approaches.

**Overview of Cyber-Physical Systems Applications:** Introduction and Motivation, System description and operational scenarios, Key design drivers and quality attributes of health care and medical CPS, Grid and energy CPS, and CPS built on wireless sensor networks.

#### TextBook(s):

1. Rajeev Alur, *Principles of Cyber-Physical Systems*, 2<sup>nd</sup>ed., London: MIT Press, 2015 (Chapters 1, 2, 3, 4, 6, 7, 9).
2. Raj Rajkumar, Dionisio de Niz and Mark Klein, *Cyber-Physical Systems*, 1st ed., New Delhi: Addison-Wesley, 2017 (Chapters 1, 7).

#### Reference Book(s):

1. E. A. Lee and S. A. Seshia, *Introduction to Embedded Systems: A Cyber-Physical Systems Approach*, 2nd ed., New Delhi: PHI Learning, 2019.
2. Fei Hu, *Cyber-Physical Systems*, 1st ed., Florida: CRC Press, 2014.

#### Web and Video link(s):

[NPTEL: Foundations of Cyber Physical Systems](#) – NPTEL Video Lecture on Foundations of Cyber Physical Systems by Soumyajit Dey, Professor of CSE, Indian Institute of Technology Kharagpur.

| Course Articulation Matrix (CAM): |            |     |     | U24OE716: CYBER PHYSICAL SYSTEMS |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|----------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                              | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24OE716.1 | 2   | 2   | 1                                | 1   | 1   | -   | -   | 1   | 1   | 1    | -    | -    | 1    |
| CO2                               | U24OE716.2 | 2   | 2   | 1                                | 1   | 1   | -   | -   | 1   | 1   | 1    | -    | -    | 1    |
| CO3                               | U24OE716.3 | 2   | 2   | 1                                | 1   | 1   | -   | -   | 1   | 1   | 1    | -    | -    | 1    |
| CO4                               | U24OE716.4 | 2   | 2   | 1                                | 1   | 1   | -   | -   | 1   | 1   | 1    | -    | -    | 1    |
| U24OE716                          |            | 2   | 2   | 1                                | 1   | 1   | -   | -   | 1   | 1   | 1    | -    | -    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                  |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                |              |                                         |                                                                                                                                                                                                                                       |
|-------------------------|--------------------------------------------------------------------------------|--------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                        | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                                                                                                 |
| CO1                     | Understand the fundamentals, architecture and models of Cyber Physical Systems | SDG9         | Industry, Innovation and Infrastructure | Cyber Physical Systems integrate computation, communication and physical processes to develop intelligent industrial systems, smart manufacturing and modern infrastructure, supporting innovation and sustainable industrial growth. |
| CO2                     | Apply synchronous and                                                          | SDG11        | Sustainable                             | Synchronous and asynchronous CPS                                                                                                                                                                                                      |

| CO-SDG Alignment Matrix |                                                                                           |                 |                                        |                                                                                                                                                                                                                      |
|-------------------------|-------------------------------------------------------------------------------------------|-----------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                   | Relevant<br>SDG | SDG<br>Description                     | Mapping Justification                                                                                                                                                                                                |
|                         | asynchronous models in CPS design and analysis                                            |                 | Cities and Communities                 | models are widely used in smart transportation, traffic control, automation and smart city applications, enabling efficient and reliable urban services.                                                             |
| CO3                     | Analyze safety, security and verification techniques in Cyber Physical Systems            | SDG16           | Peace, Justice and Strong Institutions | Synchronous and asynchronous CPS models are widely used in smart transportation, traffic control, automation and smart city applications, enabling efficient and reliable urban services.                            |
| CO4                     | Apply CPS concepts in healthcare, energy systems and wireless sensor network applications | SDG3            | Good Health and Well-being;            | CPS applications in healthcare improve patient monitoring and medical automation, while CPS-based smart grids and energy management systems enhance efficient utilization of clean and sustainable energy resources. |

| SOFTWARE QUALITY ASSURANCE AND TESTING                                                                                                                                                                                                                                                                                                     |          |             |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|-----|
| Class: B.Tech. VII-Semester                                                                                                                                                                                                                                                                                                                |          | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                               | U24OE718 | Credits :   | 3   |
| Hours/Week (L-T-P-E)                                                                                                                                                                                                                                                                                                                       | 2-1-0-3  | CIE :       | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                            | 36 Hrs   | ESE :       | 40% |
| Course Learning Outcomes (COs)                                                                                                                                                                                                                                                                                                             |          |             |     |
| After completion of this course, the student should be able to,                                                                                                                                                                                                                                                                            |          |             |     |
| CO1 : understand the scope of software quality, quality assurance processes, and quality engineering concepts                                                                                                                                                                                                                              |          |             |     |
| CO2 : apply software testing principles including realities of testing, specification examination, code examination, and blind testing techniques                                                                                                                                                                                          |          |             |     |
| CO3 : apply dynamic white-box testing, configuration testing, compatibility testing, and usability testing techniques for software evaluation.                                                                                                                                                                                             |          |             |     |
| CO4 : evaluate software testing documentation, test case design and tracking, bug reporting, and testing metrics.                                                                                                                                                                                                                          |          |             |     |
| UNIT-I                                                                                                                                                                                                                                                                                                                                     |          | 9 Hrs       |     |
| Software Quality: Perspective and expectations, Historical perspective of quality, Quality frameworks, Quality assurance as dealing with defects, Defect prevention detection and containment strategies                                                                                                                                   |          |             |     |
| Quality Assurance Process and Quality Engineering: QA activities in software processes, Verification and validation perspectives, Reconciling the two views quality engineering, Activities and process quality planning, Goal setting and strategy formation quality assessment and improvement quality engineering in software processes |          |             |     |
| UNIT-II                                                                                                                                                                                                                                                                                                                                    |          | 9 Hrs       |     |
| Software Testing Background: Infamous software case studies, Bug, why do bugs occur, The cost of bugs, Software testing functionalities, Good software tester characteristics. The Realities of Software Testing: Testing axioms, Software testing terms and definitions, Precision and accuracy, Testing quality assurance                |          |             |     |
| Examining the Specification: Black-box and white-box testing, Static and dynamic testing, Performing a high level review of the specification, Low level specification test techniques.                                                                                                                                                    |          |             |     |
| Testing the Software with Blinders On: Dynamic black-box testing, Test-to-pass and test-to-fail, Equivalence partitioning data testing, State testing, Other black-box test techniques                                                                                                                                                     |          |             |     |
| UNIT-III                                                                                                                                                                                                                                                                                                                                   |          | 9 Hrs       |     |
| Testing the Software with Dynamic White-Box Testing: Dynamic white-box testing, Dynamic white-box testing vs. debugging, Testing the pieces, Data coverage, Code coverage                                                                                                                                                                  |          |             |     |
| Configuration Testing: An overview of configuration testing, Approaching the task, Obtaining the hardware, Identifying hardware standards, Configuration testing other hardware                                                                                                                                                            |          |             |     |
| Compatibility Testing: Compatibility testing overview, Platform and application versions, Standards and guidelines data sharing compatibility                                                                                                                                                                                              |          |             |     |
| Usability Testing: User interface testing, User interface testing, Guidelines, Intuitive cons                                                                                                                                                                                                                                              |          |             |     |

istent,  
Flexible, Comfortable, Correct, Useful, Accessibility testing, Accessibility features in software

#### UNIT-IV

9 Hrs

**Automated Testing and Test Tools:** The benefits of automation and tools, Test tools, software test automation, Random testing

**Bug Bashes find Beta Testing:** Having other people test your software, Test sharing, Beta testing, Outsourcing your testing

**Writing and Tracking Test Cases:** The goals of test case planning, Test case planning overview, Test case organization and tracking

Measuring Your Success: Metrics for testing, Common project-level metrics

#### TextBook(s):

1. Jeff Tran. *Software Quality Engineering: Testing, quality Assurance. And Quantifiable Improvement*, John Wiley and IEEE Computer Society Press, 1<sup>st</sup>. ed., 2015, New Delhi.
2. Dr. Rajiv Chopra, *Software Testing and Quality Assurance*, S.K. Kataria & Sons, 5th Edition, 2023, New Delhi.[Chapter No. 1, 3, 6, 10]

#### ReferenceBook(s):

1. Kshirasagar Naik and Priyadarshi Tripathy, *Software Testing and Quality Assurance: Theory and Practice*, John Wiley & Sons, 2nd Edition, 2025, Hoboken.
2. Ron Patto, *Software Testing*, 2<sup>nd</sup> ed., SAMS Publications, 2016.
3. M.G.Limaye, *Software Testing Principles, Techniques and Tools*, Tata McGraw-Hill Education, 1<sup>st</sup>. ed., 2019, New Dehi.

| Course Articulation Matrix (CAM): |            |     |     |     | U24OE718: SOFTWARE QUALITY ASSURANCE AND TESTING |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|-----|--------------------------------------------------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3 | PO4                                              | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24OE718.1 | 1   | 2   | 2   | 2                                                | 1   | 1   | 1   | 1   | 1   | 2    | 1    | 3    | 2    |
| CO2                               | U24OE718.2 | 1   | 2   | 2   | 2                                                | 2   | 1   | 1   | 1   | -   | 2    | 1    | 3    | 2    |
| CO3                               | U24OE718.3 | 1   | 2   | 2   | 2                                                | 2   | 1   | 1   | 1   | -   | 2    | 1    | 3    | 2    |
| CO4                               | U24OE718.4 | 1   | 2   | 2   | 2                                                | 3   | 1   | 1   | 1   | -   | 2    | 1    | 3    | 2    |
| U24OE718                          |            | 1   | 2   | 2   | 2                                                | 2   | 1   | 1   | 1   | 1   | 2    | 1    | 3    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |     |                                                  |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                              |                 |                                         |                                                                                                                                          |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                      | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                    |
| CO1                     | Understand the scope of software quality, quality assurance processes, and quality engineering concepts                                      | SDG9            | Industry, Innovation and Infrastructure | Understanding software quality assurance processes supports development of reliable and innovative software infrastructure.              |
| CO2                     | Apply software testing principles including realities of testing, specification examination, code examination, and blind testing techniques. | SDG8            | Decent Work and Economic Growth         | Software testing principles improve software reliability and productivity in industrial and professional environments.                   |
| CO3                     | Apply dynamic white-box testing, configuration testing, compatibility testing, and usability testing techniques for software evaluation.     | SDG9            | Industry, Innovation and Infrastructure | Usability and compatibility testing encourage accessible and user-friendly software systems for effective digital learning environments. |
| CO4                     | Evaluate software testing documentation, test case design and tracking, bug reporting, and testing success metrics.                          | SDG9            | Industry, Innovation and Infrastructure | Documentation testing, automation, and quality metrics contribute to efficient software engineering and industrial innovation.           |

| <b>VLSI PHYSICAL DESIGN</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            |                  |                    |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>U24EC702A</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                       |                  |                    |              |
| <b>CO1:</b> interpret physical design optimizations, graph theory and common EDA terminology, partitioning algorithms and framework for multilevel partitioning<br><b>CO2:</b> identify the suitable floor planning algorithms for global and detailed placement<br><b>CO3:</b> examine the routing algorithms to address the modern challenges in detailed routing<br><b>CO4:</b> formulate the timing analysis and performance constraints for placement and routing |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |                    | <b>9 Hrs</b> |
| <b>Introduction to Electronic Design Automation:</b> VLSI design flow, VLSI design styles, layout layers and design rules, physical design optimizations, algorithms and complexity, graph theory terminology and common EDA terminology<br><br><b>Netlist and System Partitioning:</b> Introduction, terminology, optimization goals, partitioning algorithms, a framework for multilevel partitioning, system partitioning onto multiple FPGAs                       |                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                    | <b>9 Hrs</b> |
| <b>Chip Planning:</b> Introduction to floor planning, optimization goals in floor planning, terminology, floor plan representations, floor planning algorithms, pin assignment, power and ground routing<br><br><b>Global and Detailed Placement:</b> Introduction, optimization objectives, global placement, legalization and detailed placement                                                                                                                     |                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |                    | <b>9 Hrs</b> |
| <b>Global Routing:</b> Introduction, terminology and definitions, optimization goals, representations of routing regions, the global routing flow, single-net routing, full-netlist routing and modern global routing<br><br><b>Detailed Routing:</b> Terminology, horizontal and vertical constraint graphs, channel routing algorithms, switchbox routing, over-the-cell routing algorithms and modern challenges in detailed routing                                |                  |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                  |                    | <b>9 Hrs</b> |
| <b>Specialized Routing:</b> Introduction to area routing, net ordering in area routing, non-manhattan routing, basic concepts in clock networks and modern clock tree synthesis                                                                                                                                                                                                                                                                                        |                  |                    |              |

**Timing Closure:** Introduction, timing analysis and performance constraints, timing-driven placement, timing-driven routing, physical synthesis and performance-driven design flow

**TextBook(s):**

1. Andrew B.Kahng, Jens Lienig, Igor L. Markov and Jin Hu, *VLSI Physical Design: From Graph Partitioning to Timing Disclosure*, New York: Springer, 2011.(Chapters 1 to 8)

**Reference Book(s):**

1. Sarrafzadeh, Majid, and C K. Wong, *An Introduction to VLSI Physical Design*, New York: McGraw Hill, 1996.

**Web and Video link(s):**

[tel.ac.in/courses/106105161](https://www.iitkharagpur.ac.in/courses/106105161); NPTEL Video Lecture on VLSI Physical Design by Prof. Indranil Sengupta, IIT Kharagpur

| Course Articulation Matrix (CAM): |             |     |     | U24EC702A: VLSI PHYSICAL DESIGN |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|---------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                             | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC702A.1 | 2   | 2   | 1                               | 1   | 1   | -   | 1   | 1   | 1   | 1    | 1    | 2    | 2    |
| CO2                               | U24EC702A.2 | 2   | 2   | 1                               | 1   | 1   | -   | 1   | 1   | 1   | 1    | 1    | 2    | 2    |
| CO3                               | U24EC702A.3 | 2   | 2   | 1                               | 1   | 1   | -   | 1   | 1   | 1   | 1    | 1    | 2    | 2    |
| CO4                               | U24EC702A.4 | 2   | 2   | 1                               | 1   | 1   | -   | 1   | 1   | 1   | 1    | 1    | 2    | 2    |
| U24EC702A                         |             | 2   | 2   | 2                               | 1   | 1   | -   | 1   | 1   | 1   | 1    | 1    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                 |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                     |                 |                                                                                                  |                                                                                                                                                                                            |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                             | Relevant<br>SDG | SDG<br>Description                                                                               | Mapping Justification                                                                                                                                                                      |
| CO1                     | interpret physical design optimizations, graph theory and common EDA terminology, partitioning algorithms and framework for multilevel partitioning | SDG9            | Build infrastructure, promote inclusive and sustainable industrialization, and foster innovation | physical design optimizations promotes innovation in semiconductor and digital infrastructure development, supporting industrial automation and sustainable technology growth.             |
| CO2                     | identify the suitable floor planning algorithms for global and detailed placement                                                                   | SDG9            | Industry, Innovation, and Infrastructure                                                         | Modular connectivity through interfaces and placement blocks enhances design scalability and interoperability, contributing to reliable and innovative electronic infrastructure systems.  |
| CO3                     | examine the routing algorithms to address the modern challenges in detailed routing                                                                 | SDG12           | Ensure sustainable consumption and production patterns                                           | Reusable verification components and transaction-level modeling reduce redundant design efforts and resource usage, promoting sustainable engineering practices in verification workflows. |
| CO4                     | formulate the timing                                                                                                                                | SDG11           | Make cities and                                                                                  | Coverage-driven verification ensures                                                                                                                                                       |

| CO-SDG Alignment Matrix |                                                                |                 |                                                               |                                                                                                                                                     |
|-------------------------|----------------------------------------------------------------|-----------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>        | Relevant<br>SDG | SDG<br>Description                                            | Mapping Justification                                                                                                                               |
|                         | analysis and performance constraints for placement and routing |                 | human settlements inclusive, safe, resilient, and sustainable | reliable and fault-tolerant electronic systems used in smart city applications, enhancing safety and sustainability in urban technology ecosystems. |

# WIRELESS AND MOBILE COMMUNICATIONS

|                                        |           |                    |     |
|----------------------------------------|-----------|--------------------|-----|
| <b>Class:</b> B. Tech. VII – Semester  |           | <b>Branch:</b> ECE |     |
| <b>Course Code:</b>                    | U24EC702B | <b>Credits:</b>    | 3   |
| <b>Hours/Week (L-T-P-E):</b>           | 2-1-0-3   | <b>CIE:</b>        | 60% |
| <b>Total Number of Teaching Hours:</b> | 36Hrs     | <b>ESE:</b>        | 40% |

## Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** Gain insights into various mobile radio propagation models and the fading effects on the system performance
- CO2 :** Model the wireless channel in terms of large scale/small scale fading, delay spread, coherence time parameters
- CO3 :** Understand the basic concepts of Cellular System, the design requirements and CDMA technology
- CO4 :** Analyse the effectiveness of diversity techniques to mitigate the multichannel fading effects on received signals with insights on MIMO technology, channel capacity analysis, and UWB performance.

### UNIT-I

**9 Hrs**

**Wireless communications and diversity:** Fast Fading Wireless Channel Modelling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space

### UNIT-II

**9 Hrs**

**Broadband wireless channel modelling:** WSSUS Channel Modelling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading

### UNIT-III

**9 Hrs**

**Cellular communications:** Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes, Call Setup, Handover etc.

**CDMA:** Introduction to CDMA, Walsh codes, Variable tree OVSF, PN Sequences, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization

### UNIT-IV

**9 Hrs**

**MIMO:** Introduction to MIMO, MIMO Channel Capacity, MIMO Spatial Multiplexing, MIMO Diversity, MIMO, OFDM

**UWB (Ultrawide Band):** UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit Error Rate Performance of UWB

## TextBook(s):

1. T.S. Rappaport, “Wireless Communications – Principles and Practice”, 2nd edition, Pearson, 2010
2. Jochen Schiller, “ Mobile Communication”, 2nd edition, Pearson Education, 2003.

## Reference Book(s):

1. D. Tse and P. Vishwanath, "Fundamentals of Wireless Communications", 2nd edition, Cambridge Univ Press, 2005.
2. A. Goldsmith, "Wireless Communications", 2nd edition, Cambridge Univ Press, 2005
3. Ezio Biglieri, "MIMO Wireless Communications", 1st edition, Cambridge University Press, 2007.

**Web and Video link(s):**

ps://nptel.ac.in/courses/106106167;NPTEL Video Lecture on Introduction to wireless and Cellular Communications, by Prof. David Koilpillai, Professor of Electrical and Electronics department, IIT Kharagpur

| Course Articulation Matrix (CAM): |             |     |     | U24EC702B:WIRELESS AND MOBILE COMMUNICATIONS |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|----------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1 | PO2 | PO3                                          | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC702B.1 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| CO2                               | U24EC702B.2 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| CO3                               | U24EC702B.3 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| CO4                               | U24EC702B.4 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| U24EC702B                         |             | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                              |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                |                                                 |                                                                                                                            |                                                                                                                                                                                                                         |
|-------------------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                        | Relevant SDG                                    | SDG Description                                                                                                            | Mapping Justification                                                                                                                                                                                                   |
| CO1                     | Gain insights into various mobile radio propagation models and the fading effects on the system performance    | SDG 9 – Industry, Innovation and Infrastructure | Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.                | Understanding radio propagation and fading phenomena enables the design of reliable wireless communication networks, which are essential components of modern digital infrastructure and technological innovation.      |
| CO2                     | Model the wireless channel in terms of large scale/small scale fading, delay spread, coherence time parameters | SDG 9 – Industry, Innovation and Infrastructure | Develop quality, reliable, sustainable, and resilient infrastructure to support economic development and human well-being. | Wireless channel modelling helps engineers optimize network planning, improve communication reliability, and enhance the performance of broadband wireless systems, thereby strengthening communication infrastructure. |
| CO3                     | Understand the basic concepts of Cellular System, the design requirements and CDMA technology                  | SDG 11 – Sustainable Cities and Communities     | Make cities and human settlements inclusive, safe, resilient, and sustainable.                                             | Cellular communication technologies provide seamless connectivity for smart cities, emergency communication, transportation systems, and public services, contributing to sustainable urban development.                |
| CO4                     | Analyse the effectiveness                                                                                      | SDG 9 – Industry,                               | Foster innovation and                                                                                                      | Advanced wireless technologies such as MIMO, diversity techniques,                                                                                                                                                      |

| CO-SDG Alignment Matrix |                                                                                                                                                                           |                               |                                                                                                                          |                                                                                                                                                                  |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                   | Relevant<br>SDG               | SDG<br>Description                                                                                                       | Mapping Justification                                                                                                                                            |
|                         | of diversity techniques to mitigate the multichannel fading effects on received signals with insights on MIMO technology, channel capacity analysis, and UWB performance. | Innovation and Infrastructure | upgrade infrastructure through advanced technologies and increased access to information and communication technologies. | and UWB improve spectral efficiency, network capacity, and communication quality, supporting next-generation communication systems and technological innovation. |

| ADVANCED SIGNAL PROCESSING                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |             |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | U24EC702C | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                   |           |             |       |
| <b>CO1:</b> design and implement digital filters for efficient sampling rate conversion applications.<br><b>CO2:</b> analyse and implement non-parametric spectral estimation techniques such as Bartlett, Welch, and Blackman–Tukey methods.<br><b>CO3:</b> explain the fundamentals of autocorrelation and its role in parametric power spectrum estimation.<br><b>CO4:</b> apply Levinson-Durbin and Schur algorithms for efficient solution of normal equations in linear prediction analysis. |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |             | 9 Hrs |
| <b>Multirate Signal Processing:</b> Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion, Applications of Multirate Signal Processing.                                                                                                                                                                       |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |             | 9 Hrs |
| <b>Non-Parametric methods of Power Spectral Estimation:</b> Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch & Blackman & Tukey methods, Comparison of all Non-Parametric methods.                                                                                                                                                                                                                                                       |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |             | 9 Hrs |
| <b>Parametric Methods of Power Spectrum Estimation:</b> Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models - Yule-Waker & Burg Methods, MA & ARMA models for power spectrum estimation.                                                                                                                                                                                                                                                             |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |             | 9 Hrs |
| <b>Linear Prediction :</b> Forward and Backward Linear Prediction – Forward Linear Prediction, Backward Linear Prediction, Optimum reflection coefficients for the Lattice Forward and Backward Predictors. Solution of the Normal Equations: Levinson Durbin Algorithm, Schur Algorithm. Properties of Linear Prediction Filters.                                                                                                                                                                 |           |             |       |
| <b>TextBook(s):</b> <ol style="list-style-type: none"> <li>1. J.G.Proakis, D.G.Manolokis, <i>Digital Signal Processing: Principles, Algorithms &amp; Applications</i>, Pearson, 4<sup>th</sup> edition, Prentice Hall India.</li> <li>2. Alan V Oppenheim, Ronald W Schaffer, <i>Discrete Time signal processing</i>, Prentice Hall India.</li> <li>3. Emmanuel C. Ifeache, Barrie. W. Jervis, <i>DSP – A Practical Approach</i>, Pearson, 2<sup>nd</sup> edition.</li> </ol>                      |           |             |       |

**Reference Book(s):**

1. S. M .Kay, *Modern spectral Estimation : Theory & Application*, Prentice Hall of India, 1988.
2. P.P.Vaidyanathan, *Multirate Systems and Filter Banks*, Pearson Education.
3. S.Salivahanan, A.Vallavaraj, C.Gnanapriya, *Digital Signal Processing*, Tata McGraw Hill, 2000.

**Web and Video link(s):**

<p://web.iitd.ac.in/~seshan/ell720.html>

| Course Articulation Matrix (CAM): |             |      |     | U24EC702C: ADVANCED SIGNAL PROCESSING |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|-----|---------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2 | PO3                                   | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC702C.1 | 1    | 2   | 2                                     | 1    | -   | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC702C.2 | 2    | 2   | 2                                     | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO3                               | U24EC702C.3 | 2    | 2   | 2                                     | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC702C.4 | 2    | 2   | 3                                     | 3    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| U24EC702C                         |             | 1.75 | 2   | 2.25                                  | 1.75 | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |     |                                       |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                          |                 |                                         |                                                                                                                                                                                                                                      |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                  | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                                                                |
| CO1                     | design and implement digital filters for efficient sampling rate conversion applications.                                | SDG 9           | Industry, Innovation and Infrastructure | Digital filter design and multirate signal processing contribute to efficient communication systems, embedded systems, and modern digital infrastructure, promoting technological innovation and sustainable industrial development. |
| CO2                     | analyse and implement non-parametric spectral estimation techniques such as Bartlett, Welch, and Blackman-Tukey methods. | SDG 4           | Quality Education                       | Advanced spectral analysis techniques strengthen analytical, computational, and research-oriented skills in signal processing, supporting quality technical education and lifelong learning.                                         |
| CO3                     | understand the fundamentals of autocorrelation and its role in parametric power spectrum estimation.                     | SDG 9           | Industry, Innovation and Infrastructure | Parametric spectral estimation methods are widely used in communication, radar, biomedical, and AI-driven signal analysis systems, fostering innovation and development of intelligent technologies.                                 |
| CO4                     | apply Levinson-Durbin and Schur algorithms for efficient solution of normal equations in linear prediction analysis.     | SDG 8           | Decent Work and Economic Growth         | Efficient signal processing algorithms improve computational performance in speech processing, telecommunications, and automation industries, enhancing employability, productivity, and technological growth.                       |

| EMBEDDED LINUX SYSTEMS                                                                                                                                                                                                                                                                           |           |            |       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|-------|
| Class: B. Tech. VII-Semester                                                                                                                                                                                                                                                                     |           | Branch:ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                     | U24EC702D | Credits:   | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                            | 2-1-0-3   | CIE:       | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                  | 36Hrs     | ESE:       | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                 |           |            |       |
| <b>CO1 :</b> Apply Linux operating system concepts, commands, shell scripting, file systems, process management, inter-process communication, and system calls for system-level programming and administration.                                                                                  |           |            |       |
| <b>CO2 :</b> Explain Embedded Linux architecture, startup sequence, kernel structure, and apply GNU cross-platform toolchains for embedded system development.                                                                                                                                   |           |            |       |
| <b>CO3 :</b> Analyze bootloader functionality, kernel configuration and building process, and apply Linux porting techniques for embedded hardware platforms.                                                                                                                                    |           |            |       |
| <b>CO4 :</b> Explain BSP integration, embedded storage architecture, MTD drivers, memory management, and file system optimization techniques in Embedded Linux systems.                                                                                                                          |           |            |       |
| UNIT-I                                                                                                                                                                                                                                                                                           |           |            | 9 Hrs |
| <b>Review of Operating Systems:</b> review of operating systems.                                                                                                                                                                                                                                 |           |            |       |
| <b>Linux Fundamentals:</b> Introduction to Linux, Basic Linux commands and concepts, Logging in, Shells, Basic text editing, advanced shells and shell scripting, Linux File System, Linux programming, Processes and threads in Linux, Inter process communication, Devices, Linux System calls |           |            |       |
| UNIT-II                                                                                                                                                                                                                                                                                          |           |            | 9 Hrs |
| <b>Introduction to Embedded Linux:</b> Embedded Linux-Introduction, Advantage, Embedded Linux Distributions, Architecture, Linux kernel architecture, User space, Linux startup sequence, GNU cross platform Tool chain.                                                                         |           |            |       |
| <b>Learning About Toolchains:</b> Introducing toolchains,finding a toolchain, building a toolchain using cross tool-NG,Anatomy of a toolchain.{2}                                                                                                                                                |           |            |       |
| UNIT-III                                                                                                                                                                                                                                                                                         |           |            | 9 Hrs |
| <b>All About Bootloaders:</b> What does a bootloader do?The boot sequence,Bootting with UEFI firmware,moving from bootloader to kernel,introducing device trees,Choosing a bootloader,Barebox.                                                                                                   |           |            |       |
| <b>Configuring and Building the Kernel:</b> What does the kernel do?,Choosing a kernel,Building the kernel,Compiling – Kbuild,Bootting the kernel,Porting Linux to a new board.                                                                                                                  |           |            |       |
| UNIT-IV                                                                                                                                                                                                                                                                                          |           |            | 9 Hrs |
| <b>Board Support Package and Embedded Storage:</b> Inclusion of BSP in kernel build procedure, Boot loader Interface, Memory Map, Interrupt Management, PCI Subsystem,                                                                                                                           |           |            |       |

Timers, UART, Power Management, Embedded Storage, Flash Map, Memory Technology Device (MTD) –MTD Architecture, MTD Driver for NOR Flash, The Flash Mapping drivers, MTD Block and character devices, mtdutils package, Embedded File Systems, Optimizing storage space – Turning kernel memory.

**TextBook(s):**

1. Mastering Embedded Linux Programming - Second Edition by Chris Simmonds. O'Reilly Publications (*Chapters 1 to 3, 9 to 12*)
2. P. Raghavan ,AmolLad , Sriram Neelakandan, 'Embedded Linux SystemDesign and Development', Auerbach Publications 2006

**Reference Book(s):**

1. Dhananjay M. Dhamdhare, 'Operating Systems A concept basedApproach', TataMcgraw-Hill Publishing Company Ltd .
2. Chris Simmonds, "Mastering Embedded Linux Programming" - Second Edition, PACKT Publications Limited.

| Course Articulation Matrix (CAM): |             |      |     | U24EC702D :EMBEDDED LINUX SYSTEMS |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|-----|-----------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2 | PO3                               | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC702D.1 | 1    | 2   | 2                                 | 1    | -   | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC702D.2 | 2    | 2   | 2                                 | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO3                               | U24EC702D.3 | 2    | 2   | 2                                 | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC702D.4 | 2    | 2   | 3                                 | 3    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| U24EC702D                         |             | 1.75 | 2   | 2.25                              | 1.75 | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |     |                                   |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                    |                 |                                                                 |                                                                                                                                                                                                                  |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                                            | Relevant<br>SDG | SDG<br>Description                                              | Mapping Justification                                                                                                                                                                                            |
| CO1                     | Apply Linux operating system concepts, commands, shell scripting, file systems, process management, inter-process communication, and system calls for system-level programming and administration. | SDG9            | Decent Work and Economic Growth                                 | Linux and open-source system administration skills improve employability and prepare students for careers in software development, cloud computing, cybersecurity, and embedded systems industries.              |
| CO2                     | Explain Embedded Linux architecture, startup sequence, kernel structure, and apply GNU cross-platform toolchains for embedded system development.                                                  | SDG4            | Quality Education                                               | Learning Embedded Linux concepts and toolchains enhances students' technical competencies in system-level programming, preparing them for advanced studies and industry-ready embedded system development roles. |
| CO3                     | Analyze bootloader functionality, kernel configuration and building process, and                                                                                                                   | SDG9            | Promotes resilient infrastructure, inclusive industrialization, | Bootloader analysis, kernel configuration, and Linux porting are essential for developing and deploying embedded systems used in IoT devices, automotive systems, and                                            |

| CO-SDG Alignment Matrix |                                                                                                                                                           |                 |                                                                        |                                                                                                                                                                                                                      |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                   | Relevant<br>SDG | SDG<br>Description                                                     | Mapping Justification                                                                                                                                                                                                |
|                         | apply Linux porting techniques for embedded hardware platforms.                                                                                           |                 | and fosters innovation.                                                | industrial automation, thereby supporting technological innovation and infrastructure development.                                                                                                                   |
| CO4                     | Explain BSP integration, embedded storage architecture, MTD drivers, memory management, and file system optimization techniques in Embedded Linux systems | SDG12           | Ensures sustainable management and efficient use of natural resources. | Knowledge of embedded storage optimization and memory management supports efficient utilization of limited hardware resources, reducing memory wastage and improving energy-efficient and sustainable system design. |

| GENERATIVE ARTIFICIAL INTELLIGENCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |            |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|-------|
| Class: B. Tech. VII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           | Branch:ECE |       |
| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | U24EC702E | Credits    | 3     |
| Hours/Week (L-T-P-E)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 2-1-0-3   | CIE        | 60%   |
| Total Number of Teaching Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 36 Hrs    | ESE        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |            |       |
| <b>CO1 :</b> analyze generative AI foundations, including latent space representations, probabilistic modeling, and density estimation techniques for data generation.<br><b>CO2 :</b> apply and analyze deep generative models such as VAEs, GANs, and diffusion models for designing and evaluating generative systems.<br><b>CO3 :</b> analyze and apply transformer-based large language models, prompt engineering, and retrieval-augmented techniques for advanced text generation tasks.<br><b>CO4 :</b> apply, evaluate, and deploy large language model-based systems, including prompting, retrieval-augmented generation, and multimodal extensions, for real-world applications.                                                                   |           |            |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |            | 9 Hrs |
| <b>Generative AI Overview:</b> Data distributions and density estimation, Explicit vs Implicit generative models, Sampling vs inference, Applications: image synthesis, text generation, augmentation, Limitations and challenges<br><br><b>Latent Space &amp; Representation Learning:</b> Generative vs Discriminative modeling paradigms, Latent variables and embeddings, Continuous vs discrete latent spaces, Manifold hypothesis, Interpolation and arithmetic<br><br><b>Probabilistic Generative Modeling:</b> Likelihood and maximum likelihood estimation (MLE), Approximate inference and variational inference, KL divergence and its interpretation, Evidence Lower Bound (ELBO) derivation (conceptual), Sampling techniques: Monte Carlo basics |           |            |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |            | 9 Hrs |
| <b>Variational Autoencoders (VAEs):</b> Architecture and intuition, Reparameterization trick, KL regularization, Loss function, Applications<br><br><b>Generative Adversarial Networks (GANs):</b> Generator-discriminator framework, Minimax objective, Training challenges, DCGAN, Conditional GANs, Applications - image generation<br><br><b>Diffusion Models:</b> Forward and reverse diffusion, Noise prediction models, Sampling strategies, Comparison with VAEs and GANs, High-level Stable Diffusion                                                                                                                                                                                                                                                 |           |            |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |            | 9 Hrs |
| <b>Transformer Architecture:</b> Self-attention and multi-head attention, Positional encoding, Encoder-decoder vs decoder-only, Pretraining objectives (causal, masked LM), Scaling                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |            |       |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <p>laws</p> <p><b>LLMs:</b> GPT-style models, Pretraining and fine-tuning pipeline, Tokenization and embeddings, Emergent capabilities</p> <p><b>Prompt Engineering:</b> Zero-shot, few-shot learning, Instruction prompting, Chain-of-thought reasoning, Prompt design strategies</p> <p><b>Retrieval-Augmented Generation (RAG):</b> RAG architecture, Embeddings and vector search, Knowledge grounding, Reducing hallucinations</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>9 Hrs</b> |
| <p><b>LLM-based Applications:</b> Conversational AI and dialogue systems (chatbots), Text summarization (extractive vs abstractive), Machine translation using LLMs, Code generation and program synthesis, Question answering systems, Content generation (reports, blogs, documentation)</p> <p><b>LLM Adaptation and Deployment:</b> Fine-tuning vs prompt tuning, Parameter-efficient tuning (LoRA, adapters), Instruction tuning and alignment, Inference optimization and model serving, API-based deployment (LLM services), Latency, cost, and scalability considerations</p> <p><b>Multimodal Extensions of LLMs:</b> Vision-language models (LLM + vision integration), Text-to-image systems (LLM-guided generation), Image captioning using LLM frameworks, Multimodal transformers (high-level pipeline), Applications in search and accessibility, Limitations of multimodal LLMs</p> |              |
| <p><b><u>TextBook(s):</u></b></p> <ol style="list-style-type: none"> <li>1. David Foster, <i>Generative Deep Learning</i>, O'Reilly Media, 2<sup>nd</sup> edition, 2023, California. (Chapters 1 to 10)</li> <li>2. Daniel Jurafsky, James H. Martin, <i>Speech and Language Processing</i>, Pearson, 3<sup>rd</sup> edition, 2023, New Jersey. (Chapters 1 to 10, 17 to 21)</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| <p><b><u>Reference Book(s):</u></b></p> <ol style="list-style-type: none"> <li>1. Lewis Tunstall, Leandro von Werra, Thomas Wolf, <i>Natural Language Processing with Transformers</i>, O'Reilly Media, 1<sup>st</sup> edition, 2022, California.</li> <li>2. Sebastian Raschka, <i>Build a Large Language Model (From Scratch)</i>, Manning Publications, 1<sup>st</sup> edition, 2024, New York.</li> <li>3. Aurélien Geron, <i>Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow</i>, O'Reilly Media, 2<sup>nd</sup> edition, 2019, California.</li> </ol>                                                                                                                                                                                                                                                                                                                      |              |
| <p><b><u>Web and Video link(s):</u></b></p> <p><a href="https://onlinecourses.swayam2.ac.in/e-learning/preview/imb24_mg116">https://onlinecourses.swayam2.ac.in/e-learning/preview/imb24_mg116</a>; NPTEL Video Lectures on Generative AI and Large Language Models by Prof. Naveen Kumar Bhansali, IIM Bangalore.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |

| Course Articulation Matrix (CAM): |             |      |     | U24EC702E : GENERATIVE ARTIFICIAL INTELLIGENCE |     |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|-----|------------------------------------------------|-----|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2 | PO3                                            | PO4 | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC702E.1 | 3    | 3   | -                                              | 2   | -    | -   | -   | -   | -   | -    | -    | 3    | 2    |
| CO2                               | U24EC702E.2 | 3    | 3   | 2                                              | 2   | 2    | -   | -   | -   | -   | -    | -    | 3    | 3    |
| CO3                               | U24EC702E.3 | 3    | 3   | 2                                              | 3   | 2    | -   | -   | -   | 1   | 1    | -    | 3    | 3    |
| CO4                               | U24EC702E.4 | 2    | 3   | 3                                              | 3   | 3    | -   | -   | -   | 2   | 2    | 1    | 3    | 3    |
| U24EC702E                         |             | 2.75 | 3   | 2.34                                           | 2.5 | 2.34 | -   | -   | -   | 1.5 | 1.5  | 1    | 3    | 2.75 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |     |                                                |     |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                           |                 |                                         |                                                                                                                |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                   | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                          |
| CO1                     | analyze generative AI foundations, including latent space representations, probabilistic modeling, and density estimation techniques for data generation. | SDG4            | Quality Education                       | Builds strong foundational knowledge in advanced AI concepts supporting higher education and skill development |
| CO2                     | apply and analyze deep generative models such as VAEs, GANs, and diffusion models for designing and evaluating generative systems.                        | SDG9            | Industry, Innovation and Infrastructure | Enables development of innovative AI models used in modern industrial and technological applications.          |
| CO3                     | analyze and apply transformer architectures, prompt engineering strategies, and retrieval-augmented techniques for advanced text generation tasks.        | SDG9            | Industry, Innovation and Infrastructure | Supports intelligent systems such as chatbots and NLP applications driving digital innovation.                 |
| CO4                     | apply and evaluate generative AI techniques for image, multimodal, and creative applications across diverse real-world domains.                           | SDG9            | Industry, Innovation and Infrastructure | Enables deployment of scalable AI systems across industries.                                                   |

## IoT ARCHITECTURE AND PROGRAMMING

|                                        |                  |                    |            |
|----------------------------------------|------------------|--------------------|------------|
| <b>Class:</b> B. Tech. VII – Semester  |                  | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC702F</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36 Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

**CO1:** Give an overview the architecture of IoT.

**CO2 :** Explain about IoT Reference model.

**CO3:** Develop programming frameworks for the Internet of Things.

**CO4:** Apply ESP 32 & ESP 8266S for various applications.

### UNIT-I

**9 Hrs**

**IoT An Architectural Overview:** Building architecture- Main design principles and needed capabilities-An IoT architecture outline- Standards considerations- Devices and gateways-Local and wide area networking- Data management- Business processes in IoT Everything as a service (XaaS)

### UNIT-II

**9 Hrs**

**IoT Architecture Reference Model:** State of the art- European Telecommunications Standards Institute M2M/oneM2M, International Telecommunication Union Telecommunication sector view- Reference model and architecture- IoT reference model- Information model- Functional model- Communication model- Safety, privacy, trust, security model

### UNIT-III

**9 Hrs**

**Programming Frameworks for Internet of Things:**How to select an OS - Open Source, GNU licensing and Linux- Memory Managed Unit-RAM-Cache-EEPROM-flash-FPU-upgrade path-second source--object model.

**Wireless module- XBEE:** Introduction to XBEE wireless module-Pin layout-configuring module configuring the router-Loading the firmware of the module-configuring the XBEE modules-Testing the network-Hosting sensors with Raspberry pi creating a Raspberry Pi data collector for XBEE sensor nodes.

### UNIT-IV

**9 Hrs**

**ESP 32 & ESP 8266:** Introduction ESP 8266-Hardware Requirements-Software Requirements connecting to wifi- ESP 32 & ESP8266 basic applications-blinking of LED controlling tricolor LED-controlling servomotor-wiring instructions.

### TextBook(s):

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things:

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Introduction to a New Age of Intelligence”, Elsevier Science, 2014</p> <p>2. Klaus Elk, “Embedded Software Development for the Internet of Things”, CreateSpace Independent Publishing Platform, August 2016</p> <p>3. Charles Bell, “Beginning Sensor Networks with XBee, Raspberry Pi and Arduino”, Second Edition, Apress, 2020</p> <p>4. Peter Hoddie, Lizzie Prader, “IoT Development for ESP32 and ESP8266 with JavaScript”, Apress, 2020</p>                                                                                                                     |
| <p><b>Reference Book(s):</b></p> <p>1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications</p> <p>2. Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2014. S. Sridhar, <i>Digital Image Processing</i>, Oxford University Press, 2nd edition, 2016, Noida.</p> <p>3. Han-Way Huang, "Embedded system Design Using C8051", Cengage Learning 2009.</p>                                                              |
| <p><b>Web and Video link(s):</b></p> <p>1. <a href="http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html">http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html</a></p> <p>2. <a href="https://nptel.ac.in/courses/108102045">https://nptel.ac.in/courses/108102045</a></p> <p>3. <a href="https://archive.nptel.ac.in/courses/106/105/106105193/">https://archive.nptel.ac.in/courses/106/105/106105193/</a></p> <p>4. <a href="https://onlinecourses.nptel.ac.in/noc22_cs53/preview">https://onlinecourses.nptel.ac.in/noc22_cs53/preview</a></p> |

| Course Articulation Matrix (CAM): |             |      |     | U24EC702F: IoT ARCHITECTURE AND PROGRAMMING |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|-----|---------------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2 | PO3                                         | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC702F.1 | 1    | 2   | 2                                           | 1    | -   | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC702F.2 | 2    | 2   | 2                                           | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO3                               | U24EC702F.3 | 2    | 2   | 2                                           | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC702F.4 | 2    | 2   | 3                                           | 3    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| U24EC702F                         |             | 1.75 | 2   | 2.25                                        | 1.75 | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |     |                                             |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                            |                 |                                         |                                                                                                                                                          |
|-------------------------|------------------------------------------------------------|-----------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>    | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                    |
| CO1                     | Give an overview the architecture of IoT.                  | SDG9            | Industry, Innovation and Infrastructure | IoT architectures enable smart and connected infrastructure for industrial automation and intelligent systems.                                           |
| CO2                     | Explain about IoT Reference model                          | SDG11           | Sustainable Cities and Communities      | IoT reference models support development of smart city applications such as intelligent transportation, energy management, and urban monitoring systems. |
| CO3                     | Develop programming frameworks for the Internet of Things. | SDG4            | Quality Education                       | IoT programming frameworks promote technological learning and skill development in modern connected system design.                                       |

| CO-SDG Alignment Matrix |                                                         |                 |                                         |                                                                                                            |
|-------------------------|---------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i> | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                      |
| CO4                     | Apply ESP 32 & ESP 8266S for various applications       | SDG9            | Industry, Innovation and Infrastructure | ESP32 and ESP8266 enable development of innovative IoT-based automation and smart electronic applications. |

| REAL TIME OPERATING SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                              |          |            |              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------|--------------|
| Class: B. Tech. VII-Semester                                                                                                                                                                                                                                                                                                                                                                                             |          | Branch:ECE |              |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                             | U24EC703 | Credits:   | 3            |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                    | 2-1-0-3  | CIE:       | 60%          |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                          | 36Hrs    | ESE:       | 40%          |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                         |          |            |              |
| <b>CO1 :</b> Understand the fundamental concepts of operating systems, including OS structure, kernel functions, UNIX/LINUX commands, file handling, and process management system calls for developing efficient system-level applications.                                                                                                                                                                             |          |            |              |
| <b>CO2 :</b> Explain the concepts of Real Time Operating Systems (RTOS), including task scheduling, synchronization, semaphores, message queues, and inter-process communication for designing real-time and concurrent systems.                                                                                                                                                                                         |          |            |              |
| <b>CO3 :</b> Understand the concepts of RTOS objects, inter-process communication mechanisms, signals, pipes, event registers, and I/O subsystem operations for developing efficient system-level and embedded applications.                                                                                                                                                                                             |          |            |              |
| <b>CO4 :</b> Demonstrate understanding of exception handling, interrupt processing, timer management, and RTOS architectures to develop and analyze efficient real-time and embedded system applications.                                                                                                                                                                                                                |          |            |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                            |          |            | <b>9 Hrs</b> |
| <b>Introduction to Operating Systems:</b> Operating system concepts, Fundamental and Functions, Evolution of Operating Systems, Operation, Structure and Architecture of Computer Systems, OS Structure and Operations, Kernel Data Structures.<br><br>Introduction to UNIX/LINUX, Overview of Commands, File I/O,( open, create, close, lseek, read, write), Process Control ( fork, vfork, exit, wait, waitpid, exec). |          |            |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                           |          |            | <b>9 Hrs</b> |
| <b>Real Time Operating Systems:</b> Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, defining a Task, asks States and Scheduling, Task Operations, Structure,Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use,Defining Message Queue, States, Content, Storage, Operations and Use.                                                                      |          |            |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                          |          |            | <b>9 Hrs</b> |
| Objects, Services and I/O: Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem.                                                                                                                                                                                                                                                                           |          |            |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                           |          |            | <b>9 Hrs</b> |
| Exceptions, Interrupts and Timers: Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.<br><br>Case Studies of RTOS: RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, and Tiny OS.                                                                                           |          |            |              |

**TextBook(s):**

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, Tenth edition, Wiley, 2018.
2. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011.

**Reference Book(s):**

1. Advanced UNIX Programming, Richard Stevens
2. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh
3. K. C. Wang, "Embedded and Real time operating systems", Springer, 2017.
4. Jonathan Valvano, "Real time operating systems for ARM Cortex-M Microcontrollers, Embedded systems - Volume 3", ARM Educational Media, 2017.

**Web and Video link(s):**

ps://nptel.ac.in/courses/106105172; NPTEL Video Real Time Operating System, by Prof. Rajib Mall, Professor of Computer science and Engineering department, IIT Kharagpur

| Course Articulation Matrix (CAM): |            |      |     | U24EC703 :REAL TIME OPERATING SYSTEMS |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|------|-----|---------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1  | PO2 | PO3                                   | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC703.1 | 1    | 2   | 2                                     | 1    | -   | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC703.2 | 2    | 2   | 2                                     | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO3                               | U24EC703.3 | 2    | 2   | 2                                     | 2    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC703.4 | 2    | 2   | 3                                     | 3    | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| U24EC703                          |            | 1.75 | 2   | 2.25                                  | 1.75 | -   | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |     |                                       |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                                                 |                                                 |                                                                                                             |                                                                                                                                                                                                                                                                                           |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                                                                         | Relevant<br>SDG                                 | SDG<br>Description                                                                                          | Mapping Justification                                                                                                                                                                                                                                                                     |
| CO1                     | Understand the fundamental concepts of operating systems, including OS structure, kernel functions, UNIX/LINUX commands, file handling, and process management system calls for developing efficient system-level applications. | SDG 9 – Industry, Innovation and Infrastructure | Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. | provides fundamental knowledge of operating systems and system programming concepts that form the backbone of modern computing infrastructure. Understanding UNIX/LINUX systems, file management, and process control helps students build efficient and innovative software systems.     |
| CO2                     | Explain the concepts of Real Time Operating Systems (RTOS), including task scheduling, synchronization, semaphores, message queues, and inter-process communication for designing real-time and concurrent systems.             | SDG 9 – Industry, Innovation and Infrastructure | Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation  | develops knowledge of RTOS concepts used in embedded systems, automation, robotics, healthcare devices, and industrial control systems. Understanding scheduling, synchronization, and communication mechanisms enables students to design reliable and efficient real-time applications. |
| CO3                     | Understand the concepts of                                                                                                                                                                                                      | SDG 4 –                                         | Ensure inclusive                                                                                            | enhances students' technical                                                                                                                                                                                                                                                              |

| CO-SDG Alignment Matrix |                                                                                                                                                                                              |                                         |                                                                                                                         |                                                                                                                                                                                                                                                                   |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                                      | Relevant<br>SDG                         | SDG<br>Description                                                                                                      | Mapping Justification                                                                                                                                                                                                                                             |
|                         | RTOS objects, inter-process communication mechanisms, signals, pipes, event registers, and I/O subsystem operations for developing efficient system-level and embedded applications.         | Quality Education                       | and equitable quality education and promote lifelong learning opportunities for all.                                    | competencies in system-level programming and real-time communication mechanisms, promoting advanced computing skills and lifelong learning necessary for modern engineering and technology education.                                                             |
| CO4                     | Demonstrate understanding of exception handling, interrupt processing, timer management, and RTOS architectures to develop and analyze efficient real-time and embedded system applications. | SDG 8 – Decent Work and Economic Growth | Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. | equips students with industry-relevant skills in real-time computing and embedded operating systems, enhancing employability and preparing them for careers in automation, IoT, robotics, and software industries that contribute to sustainable economic growth. |

| INTERNET OF THINGS                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |             |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|--------------|
| Class: B. Tech. VII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          | Branch: ECE |              |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | U24EC704 | Credits:    | 3            |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 2-1-0-3  | CIE:        | 60%          |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 36Hrs    | ESE:        | 40%          |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                   |          |             |              |
| <b>CO1 :</b> Explain IoT fundamentals, architectures, embedded platforms, sensors and communication technologies.                                                                                                                                                                                                                                                                                                                                                                  |          |             |              |
| <b>CO2 :</b> Analyze IoT networking protocols, wireless communication systems and cloud connectivity platforms                                                                                                                                                                                                                                                                                                                                                                     |          |             |              |
| <b>CO3 :</b> Apply IoT hardware and software concepts for real-time sensing, automation and smart applications.                                                                                                                                                                                                                                                                                                                                                                    |          |             |              |
| <b>CO4 :</b> Interpret Industrial IoT, Edge AI, security and emerging IoT applications for smart systems and Industry 4.0.                                                                                                                                                                                                                                                                                                                                                         |          |             |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |             | <b>9 Hrs</b> |
| <b>Introduction to IoT and Embedded Systems:</b> Introduction to Internet of Things (IoT), Evolution of IoT, IoT Architecture, IoT Functional Blocks, IoT Applications, Embedded Systems for IoT, IoT Hardware Platforms: Arduino, ESP32 and Raspberry Pi, Sensors and Actuators fundamentals, Edge Computing and Fog Computing, Basics of Embedded C and Python for IoT.                                                                                                          |          |             |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |             | <b>9 Hrs</b> |
| <b>IoT Communication and Networking:</b> IoT Communication Models, Wired and Wireless Communication Technologies: Wi-Fi, Bluetooth, BLE, ZigBee, LoRaWAN, RFID and NFC, IPv4 and IPv6 basics, MQTT Protocol, HTTP/HTTPS, REST APIs, CoAP, JSON Data Format, IoT Gateway Concepts and Cloud Connectivity.                                                                                                                                                                           |          |             |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |             | <b>9 Hrs</b> |
| <b>IoT Sensors, Cloud Platforms and Smart Applications:</b> Temperature, Humidity, Gas, Ultrasonic, PIR, Soil Moisture and Biomedical Sensors, Sensor Interfacing Techniques, IoT Cloud Platforms: ThingSpeak, Blynk, AWS IoT and Firebase, Data Acquisition and Visualization, Mobile App Integration, Smart Home Automation, Smart Agriculture, Smart Healthcare and Smart City Applications.                                                                                    |          |             |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |             | <b>9 Hrs</b> |
| <b>Industrial IoT, Security and Emerging Technologies:</b> Industrial IoT (IIoT), Industry 4.0 concepts, Edge AI and TinyML basics, IoT Security Challenges, Authentication and Encryption, Secure Communication, AI-enabled IoT Systems, Smart Manufacturing, Connected Vehicles, Smart Grid, Digital Twin Concept and Introduction to 6G-enabled IoT.                                                                                                                            |          |             |              |
| <b>Text Book(s):</b> <ol style="list-style-type: none"> <li>1. Arshdeep Bahga and Vijay Madisetti, Internet of Things – A Hands-on Approach, Universities Press, 2015.</li> <li>2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, Cisco Press, 2017.</li> <li>3. Perry Lea, Internet of Things for Architects, Packt Publishing, 2018.</li> </ol> |          |             |              |

**Reference Book(s):**

1. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill, 2017.
2. Samuel Greengard, The Internet of Things, MIT Press, 2015.
3. Hands-On Industrial Internet of Things by Giacomo Veneri and Antonio Capasso

**Web and Video link(s):**

1. <https://onlinecourses.nptel.ac.in/> – NPTEL Video Lectures on IoT by IIT Professors.
2. <https://www.arduino.cc/en/Tutorial/HomePage> – Arduino Official Tutorials.
3. <https://docs.espressif.com/projects/esp-idf/en/latest/esp32/> – ESP32 Documentation.
4. <https://mqtt.org/> – MQTT Protocol Tutorials and Resources.

| Course Articulation Matrix (CAM): |            |      |      | U24EC704: INTERNET OF THINGS |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|------|------|------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1  | PO2  | PO3                          | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC704.1 | 2    | 2    | 1                            | -    | -    | -   | -   | -   | 1   | -    | 2    | 2    | -    |
| CO2                               | U24EC704.2 | 3    | 2    | 2                            | 2    | 1    | -   | -   | -   | -   | -    | 2    | 3    | -    |
| CO3                               | U24EC704.3 | 2    | 3    | 2                            | 2    | 2    | -   | -   | -   | 1   | -    | 2    | 2    | 3    |
| CO4                               | U24EC704.4 | 2    | 2    | 2                            | 1    | 1    | -   | 1   | -   | -   | -    | 3    | -    | 3    |
| U24EC704                          |            | 2.25 | 2.25 | 1.75                         | 1.67 | 1.33 | -   | 1   | -   | 1   | -    | 2.25 | 2.33 | 3    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |      |                              |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                               |              |                                         |                                                                                                         |
|-------------------------|---------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                       | Relevant SDG | SDG Description                         | Mapping Justification                                                                                   |
| CO1                     | Explain IoT fundamentals, architectures, embedded platforms, sensors and communication technologies.          | SDG9         | Industry, Innovation and Infrastructure | IoT technologies support modern digital infrastructure, smart connectivity and industrial innovation.   |
| CO2                     | Analyze IoT networking protocols, wireless communication systems and cloud connectivity platforms.            | SDG9         | Industry, Innovation and Infrastructure | IoT networking and cloud technologies improve reliable communication and connected infrastructure.      |
| CO3                     | Apply IoT hardware and software concepts for real-time sensing, automation and smart applications.            | SDG11        | Sustainable Cities and Communities      | IoT-based smart applications contribute to sustainable smart cities, healthcare and agriculture.        |
| CO4                     | Interpret Industrial IoT, Edge AI, security and emerging IoT applications for smart systems and Industry 4.0. | SDG7         | Affordable and Clean Energy             | Industrial IoT and intelligent automation improve energy efficiency and sustainable industrial systems. |

## COMPUTER VISION AND IMAGE PROCESSING

|                                        |                 |                    |            |
|----------------------------------------|-----------------|--------------------|------------|
| <b>Class:</b> B. Tech. VII – Semester  |                 | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC705</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>2-1-0-3</b>  | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36Hrs</b>    | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** Explain the fundamentals of image processing, computer vision and transforms on images
- CO2 :** Identify and apply different filtering techniques in the spatial domain and frequency domain to enhance digital images
- CO3 :** analyse various image compression algorithms and discover various ways to segment the objects present in the input images
- CO4 :** apply morphological image processing techniques on objects present in input images, and apply classification techniques to identify the object present in an input image

### UNIT-I

**9 Hrs**

**Introduction:** Fundamental steps and components of digital image processing, image sensing and acquisition, image sampling and quantization, some basic relationships between pixels-neighbourhood of a pixel, distance measures, Overview of Computer Vision, Applications of Image processing and Computer Vision.

**Image Transforms:** DCT, DFT, Walsh transform, Hadamard Transform, Haar transform and KL transform.

### UNIT-II

**9 Hrs**

**Intensity Transformations:** Basic intensity transformation functions, Histogram processing.

**Spatial Filtering:** Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters, Combining spatial enhancement methods.

**Filtering in Frequency Domain:** Basics of filtering in the frequency domain, image smoothing using lowpass frequency domain filters, image sharpening using highpass filters.

### UNIT-III

**9 Hrs**

**Image Compression:** Types of redundancy, image compression system model, lossless and lossy coding, Huffman coding, LZW coding, arithmetic coding, run length coding, bit-plane coding, predictive coding, JPEG 2000.

**Image Segmentation:** Fundamentals, Point, Line and edge detection, Thresholding, Segmentation by region growing and by region splitting and merging.

### UNIT-IV

**9 Hrs**

**Morphological Image Processing:** Structuring element, erosion and dilation, opening and closing, hit-or-miss transformation, basic morphological algorithms.

**Image Pattern Classification:** Background, Patterns and pattern classes, Pattern classification by prototype matching, Optimum (Bayes) statistical classifiers, Neural networks and deep learning.

**TextBook(s):**

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Pearson, 4<sup>th</sup> edition, 2018, New York. (Chapters 1 to 4, 7 to 10 & 12)
2. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall  
Robot Vision, by B. K. P. Horn, McGraw-Hill.

**Reference Book(s):**

1. Anil K. Jain, *Fundamentals of Image Processing*, Pearson, 1<sup>st</sup> edition, 2015, Chennai.
2. B. Chanda, D. Dutta Majunder, *Digital Image Processing and Analysis*, Prentice Hall of India, 2<sup>nd</sup> edition, 2011, New Delhi.
3. S. Sridhar, *Digital Image Processing*, Oxford University Press, 2<sup>nd</sup> edition, 2016, Noida.
4. Munesh C. Trivedi, *Digital Image Processing*, Khanna Book Publishing, 1<sup>st</sup> edition, 2014, New Delhi.
5. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.
6. Computer Vision, D. H. Ballard, C. M. Brown, Prentice-Hall, Englewood Cliffs, 1982.

**Web and Video link(s):**

1. [https://onlinecourses.nptel.ac.in/noc22\\_ee116/preview](https://onlinecourses.nptel.ac.in/noc22_ee116/preview); NPTEL Video Lecture on Dital Image Processing by Prof. Prabir Kumar Biaswas, Professor of EEE, IIT Kharagpur.
2. [https://onlinecourses.nptel.ac.in/noc19\\_cs58/preview](https://onlinecourses.nptel.ac.in/noc19_cs58/preview)  
[https://onlinecourses.nptel.ac.in/noc19\\_ee55/preview](https://onlinecourses.nptel.ac.in/noc19_ee55/preview)
3. Coursera Courses on Image Processing, Computer Vision

| Course Articulation Matrix (CAM): |            |      |     | U24EC705 : COMPUTER VISION AND IMAGE PROCESSING |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|------|-----|-------------------------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1  | PO2 | PO3                                             | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC705.1 | 1    | 2   | 2                                               | 1    | 2    | -   | 1   | -   | 1   | -    | -    | 2    | 2    |
| CO2                               | U24EC705.2 | 2    | 2   | 2                                               | 2    | 3    | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO3                               | U24EC705.3 | 2    | 2   | 2                                               | 2    | 3    | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC705.4 | 2    | 2   | 3                                               | 3    | 3    | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| U24EC705                          |            | 1.75 | 2   | 2.25                                            | 1.75 | 2.75 | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |      |     |                                                 |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                      |                 |                                                               |                                                                                                                                                                                                                                                                                                                           |
|-------------------------|--------------------------------------------------------------------------------------|-----------------|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                              | Relevant<br>SDG | SDG<br>Description                                            | Mapping Justification                                                                                                                                                                                                                                                                                                     |
| CO1                     | Understand fundamentals of image processing, computer vision and transforms on image | SDG 4,<br>SDG 9 | Quality Education;<br>Industry, Innovation and Infrastructure | The course outcome promotes advanced knowledge and technical skills in image processing and computer vision, enhancing quality engineering education and lifelong learning. Understanding image processing and computer vision supports innovation in automation, healthcare, surveillance, smart systems, and industrial |

| CO-SDG Alignment Matrix |                                                                                                                                                                         |                          |                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                 | Relevant<br>SDG          | SDG<br>Description                                                                          | Mapping Justification                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                         |                                                                                                                                                                         |                          |                                                                                             | applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| CO2                     | Identify and apply different filtering techniques in spatial domain, frequency domain to enhance digital images                                                         | SDG4,<br>SDG 9           | Quality Education;<br>Industry, Innovation and Infrastructure                               | The course outcome develops students' knowledge in spatial and frequency domain filtering techniques for digital image enhancement, thereby strengthening technical competency and advanced learning in image processing. It also supports innovation in areas such as medical imaging, industrial automation, remote sensing, and intelligent vision systems, contributing to modern technological infrastructure and industrial development.                   |
| CO3                     | analyze various image compression algorithms and discover various ways to segment the objects present in the input images                                               | SDG4,<br>SDG 9           | Quality Education;<br>Industry, Innovation and Infrastructure                               | The course outcome enhances students' analytical skills in image compression and image segmentation techniques, promoting advanced learning in digital image processing and computer vision. It also contributes to technological innovation in applications such as healthcare imaging, smart surveillance, multimedia communication, robotics, and automated industrial systems.                                                                               |
| CO4                     | apply morphological image processing techniques on objects present in input images and apply classification techniques to identify the object present in an input image | SDG3,<br>SDG4,<br>& SDG9 | Good Health and Well-being<br>Quality Education;<br>Industry, Innovation and Infrastructure | The course outcome develops students' ability to apply morphological image processing and classification techniques for object identification, thereby enhancing technical knowledge and problem-solving skills in computer vision. These techniques support innovation in intelligent systems, industrial automation, medical image analysis, and pattern recognition applications, contributing to technological advancement and healthcare-related solutions. |

| INTERNET OF THINGS AND SENSOR LABORATORY                                                                      |                                                                                                                              |             |     |
|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------|-----|
| Class: B. Tech. VII – Semester                                                                                |                                                                                                                              | Branch: ECE |     |
| Course Code:                                                                                                  | U24EC706                                                                                                                     | Credits:    | 1   |
| Hours/Week (L-T-P-E):                                                                                         | 0-0-2-2                                                                                                                      | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                               | 24Hrs                                                                                                                        | ESE:        | 40% |
| Course Learning Outcomes (COs)                                                                                |                                                                                                                              |             |     |
| After completion of this course, the students should be able to,                                              |                                                                                                                              |             |     |
| CO1:                                                                                                          | Demonstrate the fundamentals of Raspberry Pi architecture, GPIO interfacing, and IoT hardware components.                    |             |     |
| CO2:                                                                                                          | Implement IoT communication protocols and networking concepts for Machine-to-Machine (M2M) communication.                    |             |     |
| CO3:                                                                                                          | Develop Python programs for interfacing sensors, actuators, and embedded devices using Raspberry Pi.                         |             |     |
| CO4:                                                                                                          | Build real-time IoT systems for smart applications such as home automation, smart agriculture, and environmental monitoring. |             |     |
| Hardware Experiments:                                                                                         |                                                                                                                              |             |     |
| Experiments-1                                                                                                 |                                                                                                                              |             |     |
| 1. Study of ESP32/Arduino Architecture, GPIO Pins, Arduino IDE Installation and Embedded C Programming Basics |                                                                                                                              |             |     |
| Experiments-2                                                                                                 |                                                                                                                              |             |     |
| 2. LED Blinking, Push Button Interfacing and Buzzer Control using ESP32/Raspberry Pi                          |                                                                                                                              |             |     |
| Experiments- 3                                                                                                |                                                                                                                              |             |     |
| 3. Interfacing Temperature and Humidity Sensor (DHT11/DHT22) using ESP32 and Displaying Sensor Data.          |                                                                                                                              |             |     |
| Experiment-4                                                                                                  |                                                                                                                              |             |     |
| 4. Wi-Fi Communication using ESP32 and Transmission of Sensor Data using HTTP Protocol.                       |                                                                                                                              |             |     |
| Experiment-5                                                                                                  |                                                                                                                              |             |     |
| 5. Bluetooth/BLE Communication between Smartphone and IoT Device for Remote Monitoring                        |                                                                                                                              |             |     |
| Experiment-6                                                                                                  |                                                                                                                              |             |     |
| 6. MQTT Communication using ESP32 and Public MQTT Broker for Machine-to-Machine (M2M) Communication           |                                                                                                                              |             |     |
| Experiment-7                                                                                                  |                                                                                                                              |             |     |
| 7. Interfacing Ultrasonic Sensor for Distance Measurement and Smart Parking Application.                      |                                                                                                                              |             |     |
| Experiment-8                                                                                                  |                                                                                                                              |             |     |
| 8. IoT-based Smart Irrigation System using Soil Moisture Sensor and Relay Control.                            |                                                                                                                              |             |     |
| Experiment-9                                                                                                  |                                                                                                                              |             |     |
| 9. Uploading Real-Time Sensor Data to ThingSpeak/Blynk Cloud Platform and                                     |                                                                                                                              |             |     |

|                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Visualization using Dashboard                                                                                                                                                                                                                                                     |
| <b>Experiment-10</b>                                                                                                                                                                                                                                                              |
| 10.RFID-based Smart Attendance or Access Control System using ESP32/Raspberry Pi                                                                                                                                                                                                  |
| <b>Experiment-11</b>                                                                                                                                                                                                                                                              |
| 11.IoT-based Industrial Temperature and Gas Monitoring System with Alert Notification                                                                                                                                                                                             |
| <b>Experiment-12</b>                                                                                                                                                                                                                                                              |
| 12. Mini Project: Development of Real-Time IoT Application for Smart Home, Smart Healthcare, Smart Agriculture, Smart City or Industry 4.0 Application.                                                                                                                           |
| <b><u>TextBook(s):</u></b>                                                                                                                                                                                                                                                        |
| 1. Arshdeep Bahga and Vijay Madisetti, Internet of Things - A Hands-on Approach, Universities Press, 2015, ISBN: 9788173719547.<br>2. Matt Richardson and Shawn Wallace, Getting Started with RaspberryPi, O'Reilly (SPD), 2014, ISBN: 9789350239759                              |
| <b><u>Reference Book(s):</u></b>                                                                                                                                                                                                                                                  |
| 1. David, Hanes and Salgueiro Gonzalo, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, Pearson 2017.<br>2. Dirk Slama and Frank Puhlmann, Enterprise IoT: Strategies and Best Practices for Connected Products and Servicesby 2015 |
| <b><u>Laboratory Manual (for laboratory component):</u></b>                                                                                                                                                                                                                       |
| <i>IoT and Sensor Laboratory, Department of ECE, KITSW</i>                                                                                                                                                                                                                        |

| Course Articulation Matrix (CAM): |            |     |     | U24EC706: INTERNET OF THINGS AND SENSOR LABORATORY |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|----------------------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                                                | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC706.1 | 3   | 2   | 1                                                  | -    | 3   | -   | -   | -   | -   | 1    | -    | 2    | 2    |
| CO2                               | U24EC706.2 | 3   | 3   | 2                                                  | 1    | 3   | -   | 1   | -   | 1   | 1    | -    | 2    | 2    |
| CO3                               | U24EC706.3 | 2   | 3   | 2                                                  | 2    | 3   | -   | 1   | -   | 1   | 1    | -    | 2    | 2    |
| CO4                               | U24EC706.4 | 2   | 2   | 3                                                  | 3    | 3   | -   | 2   | -   | 2   | 1    | -    | 2    | 2    |
| U24EC706                          |            | 2   | 2   | 2                                                  | 1.75 | 3   |     | 1   | -   | 1   | 1    | -    | 2    | 2    |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW     |            |     |     |                                                    |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                           |                 |                                         |                                                                                                                                     |
|-------------------------|-----------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                   | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                               |
| CO1                     | Demonstrate the fundamentals of Raspberry Pi architecture, GPIO interfacing, and IoT hardware components. | SDG 9           | Industry, Innovation and Infrastructure | Raspberry Pi and IoT technologies promote innovation in smart embedded systems and infrastructure development.                      |
| CO2                     | Implement IoT communication protocols and networking concepts for Machine-to-Machine (M2M)                | SDG 11          | Sustainable Cities and Communities      | IoT communication enables smart city services such as intelligent transportation, smart surveillance, and connected infrastructure. |

| CO-SDG Alignment Matrix |                                                                                                                              |                 |                                        |                                                                                                         |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------|---------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                      | Relevant<br>SDG | SDG<br>Description                     | Mapping Justification                                                                                   |
|                         | communication.                                                                                                               |                 |                                        |                                                                                                         |
| CO3                     | Develop Python programs for interfacing sensors, actuators, and embedded devices using Raspberry Pi.                         | SDG 12          | Responsible Consumption and Production | Automation and smart monitoring improve resource utilization and reduce unnecessary energy consumption. |
| CO4                     | Build real-time IoT systems for smart applications such as home automation, smart agriculture, and environmental monitoring. | SDG7            | Affordable and Clean Energy            | Smart IoT systems improve energy efficiency and support sustainable automation solutions..              |

## INTERNSHIP EVALUATION

|                                        |                |                    |             |
|----------------------------------------|----------------|--------------------|-------------|
| <b>Class:</b> B. Tech. VII – Semester  |                | <b>Branch:</b> ECE |             |
| <b>Course Code:</b>                    | U24EC707       | <b>Credits:</b>    | <b>1</b>    |
| <b>Hours/Week (L-T-P-E):</b>           | <b>0-0-2-2</b> | <b>CIE:</b>        | <b>100%</b> |
| <b>Total Number of Teaching Hours:</b> | -              | <b>ESE:</b>        |             |

### Course Learning Outcomes (COs):

*After completion of this course, the students should be able to,*

- CO1:** Demonstrate understanding of professional practices, workplace ethics, and organizational functioning through internship experience
- CO2:** Apply engineering knowledge and modern tools to perform assigned tasks and solve real-world problems
- CO3:** Exhibit professional skills including communication, teamwork, leadership, and lifelong learning
- CO4:** Prepare internship reports and effectively communicate internship outcomes through presentations and viva-voce

### **Mandatory Internships:**

- The internships provide exposure to the real-world, get a feel for the work environment and how a professional workplace operates.
- During the internship, students will experience a real-life engineering workplace and understand how their engineering and professional knowledge, skills, and qualities (KSQs) can be utilized in industry.
- Students can learn, more importantly, how to apply the KSQs they have acquired during an internship to their future workplaces.
- Students will also be able to demonstrate functioning engineering knowledge, both new & existing, and identify areas of further development for their future careers.
- Internships give the student an opportunity to bridge theory and practice
- Internships also provide students with the soft skills needed at workplace and leadership positions.
- The internship guidelines are governed by the rules stipulated in the Institute's Internship Policy-2020 document.
- The students shall have to undergo 6-8 weeks of mandatory internship during summer/winter vacation at industry/R&D organization / Academic Institutes like IITs, IIITs& NITs.
- HoD, along with Prof i/c internships, shall address students (*of 2nd, 4th and 6th semesters*) during last week of even semester of every academic year on the following
  - creating awareness on mandatory 6-8 weeks internship by every student
  - creating awareness on COs of internships
  - KSQs the students would acquire doing internships
  - expected internship outcomes
  - available internship options, and organizations offering internships
  - progressively completing 6-8 weeks internship by the end of 6th semester summer,

- starting from 2nd semester summer break.
- g. internship evaluation in 7th semester
  - h. internship report submission and oral presentation ( through PPT) by student
10. Students undergoing the internship shall be required to submit their details to the department internship coordinators of the respective branches. He will coordinate all the internship activities of the students of that department.
  11. Students have to submit a signed undertaking to the department internship coordinator for demonstrating honesty, integrity, professionalism and regular attendance at work place to add value to the organization where the internship is allotted. Students also have to uphold the professional image of our institute.
  12. In case, a student is found to violate the internship rules and regulations, the student will have to produce a valid reason for the violation of internship rules. Without a valid reason, the student will be debarred from taking part in subsequent placement activities of the institute.
  13. The students preferably shall undergo internship at one organization only. In case of any difficulty, the stipulated period of internship shall be completed at different organizations with minimum of one week internship at every stage.
  14. The internship evaluation shall be done in the VII semester of study and hence the students shall complete the prescribed period of internship before start of VII semester (from end of II semester to commencement of VII semester).
  15. The student learning assessment process (SLAP): The SLAP in internships shall include feedback from internship supervisor, submission of internship report on the complete internship and PPT presentation.
  16. Internship Log Book: The activity journaling in a log book is very important for a successful internship.
    - a. The internship supervisor identifies the work goals at the beginning of the internship
    - b. Student has to maintain internship log book, where in the activities undertaken during internship and timely submission at periodic intervals are to be documented.
    - c. At the conclusion of the internship, the supervisor shall specifically comment, in the internship log book, on whether the student met each of the work goals and to give evidence which describes the quality of work. For student, this also serves as a self- assessment.
    - d. Internship log book(*with due signatures of the internship supervisor*) shall be considered for evaluation during presentation, i.e., number of planned meetings with internship supervisor and number attended by student
  17. Meeting Cadence:
    - i. **Regular meetings with internship supervisor:** Regular meetings with the internship supervisor to discuss work goals and review the status of activities undertaken are very essential. Student shall participate in discussions and take notes.
    - ii. **Meeting Frequency:** The meeting cadence, i.e., *meeting frequency* shall be fixed in consultation with the internship supervisor and accordingly student has to

participate in discussions and take notes. Take signatures of internship supervisor as per the planned cadence in the internship log book.

18. The internship evaluation shall be done by **department internship evaluation committee (DIEC)** based on the submitted report by student and oral presentation.

19. There shall be only Continuous Internal Evaluation (CIE) for internship evaluation.

20. CIE for the Internship evaluation in VII semester shall be as below:

| Internship evaluation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Weightage   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>A. Internship Supervisor's Assessment</b><br>(i) Feedback from the internship supervisor<br>- on completion of internship assignment/work (20%)<br>(ii) Feedback from the internship supervisor<br>- on quality of work in internship assignment/work (10%)<br>(iii) Feedback from the internship supervisor<br>- internship log book (10%)<br>(iv) Feedback from the internship supervisor<br>- on attendance, punctuality and work hours (10%)<br>(For the case of 6-8 week internship done in more than one spell, it will be the average of all the internship supervisors' assessments) | 50%         |
| <b>B. DIEC Assessment</b><br>(i) Internship duration (8 /12 weeks) (6/8 weeks online via NPTEL and 2/4 weeks offline) (10% / 10%)<br>(ii) Internship Report (20%)<br>(iii) Oral Presentation (with PPT) and viva voce (10%)<br>(iv) SDG (5%)<br>(v) Research Orientation (5%)                                                                                                                                                                                                                                                                                                                   | 50%         |
| <b>Total Weightage:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>100%</b> |

**Note:** It is mandatory for the student to appear for oral presentation (with PPT) and viva voce to qualify for course evaluation

(a) **Internship Report:** Each student is required to submit a well-documented internship report (both *soft copy and softbound hard copy*) as per format specified by DIEC. In case of completing the 6-8 weeks internship in more than one organization, the student shall be required to prepare separate softbound internship reports signed by the internship supervisor (s) along with the seal(s) of the organization(s). The student shall submit two final softbound internship reports along with a soft copy, keeping all the certificate(s) issued by the internship supervisor(s) and all the individual internship reports cleared by the respective internship supervisor. Chapter 1 of the final internship report shall clearly describe the following, indicating an overall summary.

- (i) **Internship(s) attended:** A table with name & address of organization, organization's vision and mission, internship weeks attended, internship period (exact dates attended), internship supervisor, head of the section and head of the organization.
- (ii) **Duties/tasks during internship(s):** Table describing name & address of organization, and the duties/tasks undertaken during internships. This indicates what opportunities and learning experiences the interns got to get

hands-on experience on a wide range of KSQs of a professional engineer.

- (iii) **Tangible outcomes of internship:** These are the lessons learnt from internship experience. The students have to describe in their own words what they learnt from the internship experience. The student has to describe what specific KSQs are acquired by him, with reference to the expected internship COs, after successful completion of internship(s). Finally, a table depicting systematic mapping of what they have learnt and the expected internship COs is to be shown.
- (iv) **Student feedback on internship:** To gather information on whether the internship was useful and gave practical experience in the chosen field of interest, and other learning, a well-defined feedback questionnaire (*made available by the dept*) with closed and open questions shall be kept in the report.
- (v) **Pictures at the worksite:** Student has to keep, in the report, his working pictures at the worksite, discussing with the internship supervisor, the creative project he is working on, or an event he is attending for work, group photo of the team/section/department he worked with.

**(b) Anti-Plagiarism Check:** The internship report should clear the plagiarism check as per the Anti-Plagiarism policy-2020 of the institute.

- (c) Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the DIEC as per the schedule notified by the department. The presentation shall compulsorily have slides on the points mentioned in (a)(i)-(v)
- (d)** It is mandatory for every student to *appear for oral presentation(with PPT) and viva-voce*, to qualify for internship evaluation
- (e)** A student shall register for supplementary examination for the internship evaluation in the following cases:
  - (i) absent for oral presentation and viva-voce
  - (ii) fails to submit the internship report in prescribed format
  - (iii) fails to fulfill the requirements of internship evaluation as per specified guidelines
- (f) Supplementary examination for internship evaluation**
  - (i) The CoE shall send the list of students registered for supplementary examination to the HoD concerned.
  - (ii) The DIEC, duly constituted by the HoD, shall conduct the internship evaluation supplementary exam and send the award list to the CoE within the stipulated time.

| Course Articulation Matrix (CAM): |            |     | U24EC707: INTERNSHIP EVALUATION |     |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|---------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC707.1 | 1   | -                               | -   | -   | -   | -   | 1   | 3   | -   | -    | -    | -    | -    |
| CO2                               | U24EC707.2 | 3   | 2                               | 1   | 1   | 3   | -   | 1   | -   | -   | -    | -    | 2    | 2    |
| CO3                               | U24EC707.3 | -   | -                               | -   | -   | -   | -   | 1   | 1   | 3   | 3    | 2    | -    | -    |

| Course Articulation Matrix (CAM): |            |     | U24EC707: INTERNSHIP EVALUATION |     |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|---------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2                             | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO4                               | U24EC707.4 | -   | -                               | -   | -   | -   | -   | 1   | -   | 1   | 3    | -    | -    | -    |
| U24EC707                          |            | 2   | 2                               | 1   | 1   | 3   | -   | 1   | 2   | 2   | 3    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |                                 |     |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                     |              |                                         |                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br>(The student should be able to...)                                                                                  | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                                                                                                                                                                                                                                                                          |
| CO1                     | Demonstrate understanding of professional practices, workplace ethics, and organizational functioning through internship experience | SDG 4        | Quality Education                       | Industrial internship provides experiential learning in ECE domains such as Embedded Systems, IoT, VLSI, Communication Systems, Signal Processing, Artificial Intelligence, and Semiconductor Technologies. Students acquire practical skills, industry exposure, professional networking opportunities, and lifelong learning abilities, thereby strengthening quality technical education and employability. |
| CO2                     | Apply engineering knowledge and modern tools to perform assigned tasks and solve real-world problems                                | SDG 11       | Sustainable Cities and Communities      | Effective communication and collaboration are essential for multidisciplinary ECE projects such as smart city infrastructure, intelligent transportation systems, public safety networks, and digital communication platforms that contribute to sustainable and connected communities.                                                                                                                        |
| CO3                     | Exhibit professional skills including communication, teamwork, leadership, and lifelong learning                                    | SDG 9        | Industry, Innovation and Infrastructure | Application of ECE concepts to industrial problems through communication networks, embedded systems, IoT, VLSI, robotics, AI-enabled systems, and automation technologies promotes innovation, industrial modernization, and sustainable infrastructure development.                                                                                                                                           |
| CO4                     | Prepare internship reports and effectively communicate internship outcomes through presentations and viva-voce                      | SDG 12       | Responsible Consumption and Production  | Professional ethics, quality assurance, responsible technology deployment, resource optimization, and sustainable engineering practices in ECE industries encourage responsible production, efficient use of resources, and continuous improvement.                                                                                                                                                            |

| MAJOR PROJECT PHASE 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |             |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|------|
| Class: B. Tech. VII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          | Branch: ECE |      |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | U24EC708 | Credits:    | 4    |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0-0-8-8  | CIE:        | 100% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -        | ESE:        |      |
| <b>Course Learning Outcomes (COs):</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |             |      |
| CO1: review research literature, identify gaps in the literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real-world complex engineering problems ( <b>Technical skills</b> )<br>CO2: design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a real-world problem guided by ethical, environmental, societal and sustainable development considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget ( <b>Problem solving and critical thinking skills</b> )<br>CO3: apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader to produce time-sensitive deliverables in a multi-disciplinary team ( <b>Ethics and teamwork</b> )<br>CO4: collate the results, compare performance of prototype to design specifications and present clearly and effectively the proposed solution, conclusions and/or recommendations in written (report, poster, technical paper), oral (presentations) and multimedia formats (video pitch) and engage in self-directed independent learning and life-long learning demonstrating the KSQ of a professional engineer ( <b>Communication skills and life-long learning</b> )                                                                                                                                                                                                              |          |             |      |
| 1. Final Year Major Project work represents the culmination of study towards the B. Tech degree. <b>Major project offers an opportunity to integrate the knowledge acquired from various courses and apply it to solve real-world complex engineering problems.</b> The <b>student learning assessment process</b> (SLAP) shall include good number of presentations, demonstration of work undertaken, submission of a project report, writing project paper in scientific journal style & format, preparing project poster and creating video pitch on the complete project work.<br>2. Activities of major project SLAP shall be planned in such a way to ensure that the students acquire the essential knowledge, skills and qualities (KSQ) of a professional engineer.<br>3. <b>Team work:</b> Major project work is a team work.<br>(i) The students of a project team shall work together to achieve a common objective.<br>(ii) Every student of a project team is expected to function effectively as an individual, and also with others as a team member in an ecosystem of a team having knowledge diversity, gender diversity, social and cultural diversity among its members.<br>4. <b>Two phases:</b> Major project work shall be carried out in two phases. Nearly 50 - 75% of the proposed work to be completed in 7 <sup>th</sup> semester as <i>Phase-I</i> and the remaining work to be continued and completed in 8 <sup>th</sup> semester as <i>Phase-II</i> .<br>5. Every student is expected to put approximately 72 hours of work into the major project <i>phase-I</i> course over the 12 weeks of 7 <sup>th</sup> semester.<br>6. <b>Major project work Phase-I: 7<sup>th</sup> semester</b><br>(i) The HoD shall constitute the <b>department project evaluation committee (DPEC)</b> with following composition |          |             |      |

| <b>Department project evaluation committee (DPEC)</b> |                                                                                                                                                                                                       |  |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| HoD                                                   | Chairman                                                                                                                                                                                              |  |
| Senior Faculty                                        | Convener                                                                                                                                                                                              |  |
| Coordinator(s)                                        | Section-wise coordinator(s)<br><i>One coordinator for each section</i>                                                                                                                                |  |
| Three Faculty members                                 | Section-wise faculty members<br><i>Three faculty members for each section representing various specializations. (Five specializations will be covered including the coordinator's and Convener's)</i> |  |

(ii) Major project allotment to students during last working week of 6<sup>th</sup> semester:

- First / Second week of 6<sup>th</sup> Semester:** The process shall be initiated during the first / second week of 6<sup>th</sup> semester by collecting project titles from the department faculty research groups, on offering innovative ideas/solutions for engineering problems.
- MSE-I period of 6<sup>th</sup> Semester – Notifying project titles:** The finalized project titles shall be notified to students during the MSE-I period of 6<sup>th</sup> semester and student teams shall be allowed to exercise their options on titles that interest them.
- Last working week of 6<sup>th</sup> Semester – Allotment of titles and supervisors to project teams:** The project title allotment to major project teams shall be completed before the last day of instruction of 6<sup>th</sup> semester
- 6<sup>th</sup> semester summer break - Literature review:** This 6<sup>th</sup> semester schedule enables students to complete literature review, preliminary simulations / investigations / experimentation during 6<sup>th</sup> semester summer break and *start the work from day-one in 7<sup>th</sup> semester*
- Registration Presentation - Notifying the tentative dates:** The major project teams are expected to give registration presentation during second / third week from the commencement of 7<sup>th</sup> semester. The tentative dates for conducting the registration presentation shall be notified at the time of releasing the circular on allotted project title and project supervisors, as indicated in (c) above. This enables student teams to plan the work accordingly during summer break, to complete the literature review, preliminary simulations / investigations and get ready for informative, confident and comfortable presentations on their project work.

(iii) The convener DPEC shall notify, during MSE-I period of 6<sup>th</sup> semester, the list of implementable project titles offered by the faculty of different research groups of the department

- Project titles shall come with the following details to be made available to students on dept webpage and notice boards, facilitating students to select problems that interest them.
  - abstract
  - deliverables / outcomes
  - knowledge and skills required to complete the project
  - resources required
  - one of the deliverables shall be writing a technical paper out of the major project work done for submission to a reputed non-predatory conference/non-paid peer reviewed journal

(iv) The major project teams, finalized by the convener DPEC, shall be allowed to exercise their options on the titles that interest them from the notified list

(v) **Project supervisor allotment:** The convener DPEC shall allot, during the last week of 6<sup>th</sup> semester, the faculty supervisors to all project teams

- The project supervisors shall
  - define project objectives and expected deliverables**
  - help the students plan their project work and timeline**

**iii. provide enough resources for successful project completion**

- (vi) The faculty supervisors are expected to provide guidance to project teams on
- (a) *Knowledge, skills and qualities (KSQ) to be acquired* to propose solutions to the identified real-world problems
  - (b) *Problem analysis* - to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
  - (c) *Applying engineering knowledge* - to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
  - (d) *Design/development of solutions* - to design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental Considerations
  - (e) *Conduct investigations of complex problems* - to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
  - (f) *Modern tool usage* - to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
  - (g) *The Engineering and the world* - to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
  - (h) *Ethics* - to apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice
  - (i) *Individual and team work* - to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
  - (j) *Communication* - to communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
  - (k) *Project management and finance* - to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
  - (l) *Life-long learning* - to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
- (vii) The project supervisors are also expected to continuously emphasize and guide students on
- (a) **Meeting Cadence:**
    - i. **Regular meetings with supervisor:** Short and frequent meetings increase a team's work momentum. Regular meetings with supervisor to review the status of project are very essential. All students of the team shall participate in discussions and take notes.
    - ii. **Meeting Frequency: Semi-weekly cadence**, i.e., the meeting frequency shall be **twice a week**. Due weightage will be given to meeting cadence and considered for evaluation during presentations, i.e., number of planned meetings and number attended by students
  - (b) **Project Log Book:** The activity journaling in project logbook is very important for a successful project.
    - i. Project log book is a written record showing the daily project activity on project goals from the very first thing like starting the project (an introduction statement what the project is all about), to the completion of the work

- (including the final results, and whether project met the core objectives / outcomes, etc.).
- ii. In project log book, the activities like regular meetings with project supervisor, and work carried out on daily/weekly basis are to be recorded. This ensures that the student progress is being monitored well.
  - iii. The project supervisor shall regularly check the log book of every student of project team and endorse each and every activity by affixing his signature with date. With this, the number of planned meetings and number attended by the students will be also monitored.
  - iv. Log books are to be shown during all presentations and will be graded along with the project.
  - v. At the conclusion of the project work *phase-I*, the supervisor shall specifically comment, in the project log book, on whether the project team met each of the project work *phase-I* goals and to give evidence which describes the quality of work. For project teams, this also serves as self-assessment.
- (c) **Following project timeline:** completing the tasks as planned in project timeline
  - (d) The relevant knowledge, skills and qualities (**KSQ**) an engineering graduate should possess, which can be specially acquired by participating in major project work
  - (e) **Writing down whatever is done and making notes of whatever is read.** Writing down the procedures/models followed, designs made, experiments conducted, simulations carried out, intermediate results obtained, ***difficulties faced and how they were fixed*** are very important. This kind of documenting the whole process as we go with project implementation is a very effective way and will help preparing a well- documented report having original content. Note down and include information about all the resources that you used, magazines, Journals, patents, books, and so on.  
This information will be needed for the bibliography in your project report. On the other hand, documenting a report on ***the spur of the moment*** would end up copying things from other sources resulting in a plagiarized document.
  - (f) **Good and sufficient literature review:** Literature review is a description and analysis of information related to the topic of project work. Reading good number of review articles, research articles published in recent issues of peer reviewed journals, technical magazines, patents, reference books on the topics of potential interest, will help one understand what has already been discovered and what questions remain to identify gaps in the literature.
  - (g) Completing nearly 50 - 75% of the proposed work during phase-I
  - (h) Right conduct of research to promote academic integrity, honesty and time management
  - (i) Preparing a well-documented report in proper format, covering the progress made during Phase-I
  - (j) Consequences of plagiarism and use of anti-plagiarism software to detect plagiarism in documents
  - (k) Submission of major project phase-I report within acceptable plagiarism levels, as per the ***Anti-plagiarism policy-2020 of our institute***.
  - (l) **Video pitch:** Capturing short videos, photos, screenshots on experiments conducted, simulations carried out, prototype / working model / process / software package / system developed during course of project execution, photos showing interaction with supervisor for creating a short video pitch on the work done during *phase-I*.
  - (m) **Project Paper:** Writing a technical paper at the end of *phase-II* based on the solution(s) proposed, results obtained, and prototype / working model / process / software package / system developed, for submission to a reputed non-predatory conference/non-paid peer reviewed journal.

- (n) **Project poster:** At the end of phase-II, the project teams shall have to present their project in the form of posters, at the time of demonstration of complete prototype / working model / software package / system developed.
- (viii) **Phase– I evaluation:** There shall be only Continuous Internal Evaluation (CIE) for major project work *phase-I* with following components
- (a) **Registration Presentation** (*during second / third week of 7th semester*): The Registration Presentation shall include a brief report and presentation focusing the identified problem, objective(s), literature review, identifying research gap in the literature, implementation of existing methods, proposed solution, and expected outcome(s).
- i. The registration presentation shall invariably include the **project plan timeline** with actual start and finish dates– monthly/weekly project milestones/ timeline prepared in MS Excel or any other project management tool.
  - ii. **Project timeline – Weekly project milestones:** It's a compact and creative way to present a project plan. Identify the project intermediate goals and related tasks for completing each of those goals. Categorize tasks for each week. In the project timeline use different colors to the tasks for each week. Horizontal timeline layouts shall be preferred or any other layout of team's choice.
  - iii. Project teams shall create and present the following during registration presentation
    1. Complete project timeline
    2. Phase-I project timeline
    3. Phase-II project timeline
  - iv. During every presentation, project teams shall compulsorily show the following as part of their presentation
    1. The slides on project timeline and
    2. A table showing targeted tasks as per timeline and status – whether tasks accomplished?
  - v. **Project log book:** Every student of the Project team shall compulsorily show the activity journaling in the log book (*with due signatures of project supervisor*) during presentations
- (b) **Progress Presentation-I** (*during penultimate week of 7th semester*): At the end of first stage (7th semester), student teams shall be required present, before the DPEC, the progress made during phase-I and submit a well-documented report of work done for evaluation to the project coordinator
- i. **Following project timeline:** The project timeline shall be meticulously followed and the tasks shall be completed as planned in the project timeline.
  - ii. Project teams shall compulsorily show the following as part of their progress presentation-I
    1. The slides on project timeline and
    2. A table showing targeted tasks as per timeline and whether tasks are accomplished?
  - iii. **Project log book:** Every student of the Project team shall compulsorily show the activity journaling in the log book (*with due signatures of project supervisor*)
- (c) **CIE schedule:** The convener DPEC shall release the complete schedule of CIE before start of 7th semester well in advance, so that student teams will complete the scheduled works and get ready with an informative, confident, and comfortable presentation for registration and progress presentations.
- (ix) CIE for the Major project work Phase-I shall be as given below:

| Major project work Phase-I Assessment (7th semester)                                                                                                                                                                                                                                                          | Weightage    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>A. Supervisor Assessment</b>                                                                                                                                                                                                                                                                               | <b>20%</b>   |
| <b>B. DPEC Assessment</b><br>(i) Registration Presentation (10%)<br>(ii) Progress Presentation-I (20%)<br>(iii) Project progress*: Part of working model/ process/software package/system developed (30%)<br>(iii) Well-documented Progress Report on Phase-I work (10%)<br>(iv) Video pitch on Phase-I (10%) | <b>80%</b>   |
| <b>Total Weightage</b>                                                                                                                                                                                                                                                                                        | <b>100 %</b> |

\* Students are advised to complete major part of the project in phase-I only

- (a) **Working Model:** Every project team shall be required to develop a working model/ process/software package/system, on the chosen work. The progress made in this shall be demonstrated during progress presentation-I at the end of *phase-I* and the completed working model/ process/software package/system before the DPEC as per the dates specified by DPEC at the end of *phase-II*.

- (b) **Progress Report on phase-I:** Every project team shall be required to submit a well-documented progress report on dissertation phase-I as per format specified by DPEC.

- a. **Tangible outcomes of phase-I in Conclusions - Chapter:** These are the lessons learnt from doing a project work. The students have to describe in their own words what they learnt from the *phase-I* project work experience. They have to describe what specific KSQs are acquired by them, with reference to the expected COs, after successful completion of *phase-I* work. Finally, a table depicting systematic mapping of what they have learnt and the expected major project work COs, is to be presented in the conclusions chapter of *phase-I* report

- (c) **Video pitch on phase-I:** Every project team shall be required to create a pitch video, which is a video presentation on their major project work *phase-I*. The project team shall present the produced video pitch during progress presentation-I. The produced video pitch should

- be 3 to 5-minute-long video (no longer than 5 minutes)
- be concise and to the point, on the problem and proposed solution
- show project timeline and sample page of log book
- highlight the progress made at various stages during *phase-I* project implementation with the help of short videos/photos / screenshots on experiments conducted, simulations carried out, part of prototype/ working model/process / software package/system being under development as part of proposed solution and also photos showing team interactions with supervisor and the team working in the lab on project
- discuss the impact of proposed solution in *ethical, environmental, societal and sustainable development contexts*.
- emphasize key points about *business idea, potential market for the proposed solution*

- (x) It is mandatory for

- every student of the team to *appear for oral presentation and viva-voce*, as part of progress presentation -I to qualify for course evaluation
- every project team to *submit a well-documented progress report on major project work phase-I*, as part of progress presentation -I to qualify for course evaluation
- every project team to create and present a good video pitch on major project work *phase-I*, as part of progress presentation -I to qualify for course evaluation

- (xi) A student shall register for supplementary examination for the Major project work *phase-I*

in the following cases:

- (a) He/she is absent for oral presentation and viva-voce as part of progress presentation-I
- (b) The project team fails to submit the progress report on *Phase-I* in prescribed format
- (c) The project team fails to submit the video pitch on the progress made during the *phase-I* period.
- (d) he/she fails to fulfill the requirements of Major project work *phase-I* evaluation as per specified guidelines

(xii) Supplementary examination for Major project work *phase-I*

- (a) The CoE shall send the list of students registered for supplementary examination to the HoDs concerned
- (b) The DPEC, duly constituted by the HoD, shall conduct Major Project Phase I supplementary exam and send the award list to the CoE within the stipulated time

| Course Articulation Matrix (CAM): |            |     |     | U24EC708: MAJOR PROJECT PHASE I |     |     |      |     |     |      |      |      |      |      |
|-----------------------------------|------------|-----|-----|---------------------------------|-----|-----|------|-----|-----|------|------|------|------|------|
| CO                                |            | PO1 | PO2 | PO3                             | PO4 | PO5 | PO6  | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC708.1 | 3   | 3   | 2                               | 3   | 2   | 1    | 1   | 1   | 1    | 1    | 2    | 2    | 2    |
| CO2                               | U24EC708.2 | 3   | 3   | 3                               | 2   | 3   | 3    | 2   | 1   | 1    | 2    | 2    | 2    | 1    |
| CO3                               | U24EC708.3 | 1   | 1   | 1                               | 1   | 1   | 2    | 3   | 3   | 2    | 3    | 1    | 2    | 1    |
| CO4                               | U24EC708.4 | 1   | 1   | 1                               | 2   | 2   | 1    | 2   | 1   | 3    | 1    | 3    | 2    | 2    |
| U24EC708                          |            | 2   | 2   | 1.75                            | 2   | 2   | 1.75 | 2   | 1.5 | 1.75 | 1.75 | 2    | 2    | 1.5  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                 |     |     |      |     |     |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                                                                                                                                                                       |              |                                         |                                                                                                                                                                                                                                                                                               |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                                                                                                                                                                                                                                                                                       | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                                                                                                                                                         |
| CO1                     | review research literature, identify gaps in the literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real-world complex engineering problems (Technical skills) | SDG 9        | Industry, Innovation and Infrastructure | Research gap identification, problem formulation, and development of innovative engineering solutions promote technological advancement, industrial innovation, and sustainable infrastructure development in ECE domains such as communication systems, IoT, VLSI, AI, and embedded systems. |
| CO2                     | design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a real-world problem guided by ethical, environmental, societal and sustainable development                                                                               | SDG 12       | Responsible Consumption and Production  | Engineering design considering resource optimization, environmental impact, sustainability, and efficient utilization of technology promotes responsible production and sustainable engineering practices.                                                                                    |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                                       |              |                                    |                                                                                                                                                                                                                                     |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                                                                                                                                                       | Relevant SDG | SDG Description                    | Mapping Justification                                                                                                                                                                                                               |
|                         | considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget (Problem solving and critical thinking skills)                                 |              |                                    |                                                                                                                                                                                                                                     |
| CO3                     | Apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader of a multidisciplinary team.  | SDG 11       | Sustainable Cities and Communities | Effective teamwork, ethical engineering practices, leadership, and multidisciplinary collaboration facilitate the development of sustainable technological solutions that improve societal well-being and community infrastructure. |
|                         |                                                                                                                                                                                                                       | SDG3         | Good Health and Well-Being         | ECE projects related to biomedical instrumentation, healthcare IoT, telemedicine, wearable sensors, and assistive technologies contribute to improved healthcare services and quality of life.                                      |
| CO4                     | Collate results, compare prototype performance with specifications, communicate findings through reports, posters, technical papers, presentations, and video pitches; engage in self-directed and lifelong learning. | SDG 4        | Quality Education                  | Technical communication, dissemination of knowledge, professional documentation, and lifelong learning foster continuous education, skill enhancement, and knowledge sharing among engineering professionals.                       |

# 8<sup>th</sup> Semester Syllabus

**VIII SEMESTER**

| S. No.                                                          | Category | Course Code | Course Title                                         | Lectures / week |   |    |    | Credits |
|-----------------------------------------------------------------|----------|-------------|------------------------------------------------------|-----------------|---|----|----|---------|
|                                                                 |          |             |                                                      | L               | T | P  | E  | C       |
| 1                                                               | PEC      | U24EC801    | Program Elective - III / MOOCs-III                   | 2               | 1 | -  | 3  | 3       |
| 2                                                               | PEC      | U24EC802    | Program Elective - IV / MOOCs-IV                     | 2               | 1 | -  | 3  | 3       |
| 3                                                               | PCC      | U24EC803    | Radar and Satellite Communications                   | 2               | 1 | -  | 3  | 3       |
| 4                                                               | ELC      | U24EC804    | Major Project, Phase - 2 / Industrial Internship - 2 | -               | - | 12 | 12 | 6       |
| Total:                                                          |          |             |                                                      | 6               | 3 | 12 | 21 | 15      |
| Additional Learning@: Maximum credits allowed for Honours/Minor |          |             |                                                      | -               | - | -  | -  | 4       |
| Total credits for Honours/Minor students:                       |          |             |                                                      | -               | - | -  | -  | 19      |

**#MULTIDISCIPLINARY OPEN ELECTIVES:** Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

**@** List of courses for additional learning through MOOCs towards Honours/Minor in Engineering shall be prescribed by the department under Honours/Minor Curricula

**B. Tech Honours with Research**

Students opting for B. Tech Honours with Research, shall Publish a research paper in reputed journal indexed by SCI/ SCOPUS/Web of Science (4 Credits).

| <b>LOW POWER VLSI</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  |                    |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>U24EC801A</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                     |                  |                    |              |
| <b>CO1 :</b> illustrate the importance of low power design<br><b>CO2 :</b> identify the various source of power consumption inCMOS circuits<br><b>CO3 :</b> develop the techniques to reduce the power dissipation in CMOS circuits<br><b>CO4 :</b> examine the circuit with probabilistic power technique                                                                                                                                                                                           |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                  |                    | <b>9 Hrs</b> |
| Introduction: Motivation for low power VLSI design, Sources of power dissipation in Digital Integrated circuits. Emerging Lowpower approaches. Dynamic dissipation in CMOS, Effect of supplyvoltage and Threshold voltage, Impact of technology Scaling,Technology & Device innovation. Circuit Techniques for low powerdesign: techniques for leakage power reduction. Low-PowerDesign Through Voltage Scaling, Estimation and Optimization ofSwitching Activity, Reduction of Switched Capacitance |                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                    | <b>9 Hrs</b> |
| SPICE circuit simulation, gate level logic simulation, capacitive, power estimation, static state power, gate level capacitance, estimation, architecture level analysis. Probabilistic power, analysis: Random logic signals, probability & frequency,probabilistic power analysis techniques, signal entropy.                                                                                                                                                                                      |                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                    | <b>9 Hrs</b> |
| Low Power Circuit's: Transistor and gate sizing, networkrestructuring and Reorganization. Logic level: Gate reorganization,signal gating, logic encoding, state machine encoding, precomputation logic. Energy Recovery CMOS: energy dissipation intransistor channel using RC model, adiabatic dynamic logic circuit                                                                                                                                                                                |                  |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                    | <b>9 Hrs</b> |
| Leakage Power minimization Approaches: Variable-thresholdvoltage CMOS (VTCMOS) approach multi-threshold-voltage CMOS(MTCMOS) approach Power gating Transistor stacking Dual-Vtassignment approach (DTCMOS)                                                                                                                                                                                                                                                                                           |                  |                    |              |
| <b><u>TextBook(s):</u></b> <ol style="list-style-type: none"> <li>1. Kang, Sung Mo, and Yusuf Leblebici, <i>CMOS digital integrated circuits</i>, New York, NY, USA: MacGraw-Hill, 2003.</li> <li>2. Weste, Neil HE, and Kamran Eshraghian, "Principles of CMOS VLSI design: a systems perspective," <i>NASA STI/Recon Technical Report A 85</i> (1985): 47028.</li> </ol>                                                                                                                           |                  |                    |              |

**Reference Book(s):**

3. Bellaouar, Abdellatif, and Mohamed Elmasry, *Low-power digital VLSI design: circuits and systems*, Springer Science & Business Media, 2012.

**Web and Video link(s):**

<https://nptel.ac.in/courses/106105034>; NPTEL Video Lecture on Low Power VLSI Circuits & Systems by Prof. Ajit Pal, IITKharagpur.

| Course Articulation Matrix (CAM): |             |     |     | U24EC801A : LOW POWER VLSI |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|----------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                        | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC801A.1 | 3   | 2   | 3                          | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO2                               | U24EC801A.2 | 3   | 2   | 3                          | 2   | 3   | 1   | 1   | 2   | 1   | 2    | 2    | 3    | 2    |
| CO3                               | U24EC801A.3 | 2   | 3   | 3                          | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| CO4                               | U24EC801A.4 | 2   | 3   | 3                          | 3   | 3   | 1   | 1   | 3   | 2   | 2    | 3    | 3    | 2    |
| U24EC801A                         |             | 2.5 | 2.5 | 3                          | 2.5 | 3   | 1   | 1   | 2.5 | 1.5 | 2    | 2.5  | 3    | 2.5  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                            |     |     |     |     |     |     |      |      |      |      |

**CO-SDG Alignment Matrix**

| CO  | CO Statement<br><i>The student should be able to...</i>                 | Relevant<br>SDG | SDG<br>Description                                                                               | Mapping Justification                                                                                                                                                                      |
|-----|-------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | illustrate the importance of low power design                           | SDG9            | Build infrastructure, promote inclusive and sustainable industrialization, and foster innovation | RTL design using SystemVerilog promotes innovation in semiconductor and digital infrastructure development, supporting industrial automation and sustainable technology growth.            |
| CO2 | identify the various source of power consumption in CMOS circuits       | SDG9            | Industry, Innovation, and Infrastructure                                                         | Modular connectivity through interfaces and clocking blocks enhances design scalability and interoperability, contributing to reliable and innovative electronic infrastructure systems.   |
| CO3 | develop the techniques to reduce the power dissipation in CMOS circuits | SDG12           | Ensure sustainable consumption and production patterns                                           | Reusable verification components and transaction-level modeling reduce redundant design efforts and resource usage, promoting sustainable engineering practices in verification workflows. |
| CO4 | examine the circuit with probabilistic power technique                  | SDG11           | Make cities and human settlements inclusive, safe, resilient, and sustainable                    | Coverage-driven verification ensures reliable and fault-tolerant electronic systems used in smart city applications, enhancing safety and sustainability in urban technology ecosystems.   |

| FREE SPACE OPTICAL COMMUNICATION                                                                                                                                                                                                                                                                                                                                                                               |           |             |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                   | U24EC801B | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                          | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                               |           |             |       |
| <b>CO1 :</b> Understand fundamentals of FSO communication systems and optical devices.<br><b>CO2 :</b> Analyze atmospheric effects and channel impairments in FSO links..<br><b>CO3 :</b> Apply modulation and detection techniques for FSO performance analysis<br><b>CO4 :</b> Design and evaluate FSO systems for modern wireless communication applications.                                               |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                         |           |             | 9 Hrs |
| <b>Introduction to Optical Wireless Communication:</b> Overview of Optical Communication Systems, Free Space Optical (FSO) communication concept and advantages, comparison of optical fiber and FSO systems. Basic components of FSO system: transmitter, channel, receiver. Optical sources: LED and LASER diodes, characteristics and modulation. Photodetectors: PIN diode and Avalanche Photodiode (APD). |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                        |           |             | 9 Hrs |
| <b>FSO Channel Modelling and Propagation Effects:</b> Atmospheric propagation of optical signals, absorption and scattering losses. Atmospheric effects: fog, rain, snow, haze and turbulence. Beer-Lambert Law for attenuation, link margin analysis. Pointing errors, alignment issues, background noise and interference.                                                                                   |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                       |           |             | 9 Hrs |
| <b>Modulation, Detection and Performance Analysis:</b> Intensity modulation techniques: On-Off Keying (OOK), Pulse Position Modulation (PPM). Coherent and non-coherent detection techniques. Receiver noise sources, Signal-to-Noise Ratio (SNR), Bit Error Rate (BER) analysis and link budget calculations.                                                                                                 |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                        |           |             | 9 Hrs |
| <b>FSO System Design and Applications:</b> FSO system design considerations, link design and optimization. Hybrid RF-FSO systems, MIMO techniques and adaptive optics. Applications of FSO systems in satellite communication, inter-building communication and last-mile connectivity. Challenges and future trends in 5G backhaul and space optical communication.                                           |           |             |       |
| <b><u>TextBook(s):</u></b> <ol style="list-style-type: none"> <li>Free-Space Optical Communication Systems by Arun K. Majumdar and Jennifer C. Ricklin</li> <li>Optical Wireless Communications by Z. Ghassemlooy, W. Popoola, and S. Rajbhandari</li> </ol>                                                                                                                                                   |           |             |       |

**Reference Book(s):**

1. Wireless Optical Communication Systems by Murat Uysal
2. Optical Fiber Communications by Gerd Keiser
3. Fiber-Optic Communication Systems by Govind P. Agrawal

| Course Articulation Matrix (CAM): |             |     |     | U24EC801B :FREE SPACE OPTICAL COMMUNICATION |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|---------------------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                                         | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC801B.1 | 3   | 2   | 1                                           | 1    | 2    | 1   | -   | -   | -   | -    | -    | 2    | 2    |
| CO2                               | U24EC801B.2 | 2   | 2   | 3                                           | 2    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC801B.3 | 2   | 2   | 3                                           | 3    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC801B.4 | 1   | 2   | 2                                           | 3    | 3    | 3   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC801B                         |             | 2   | 2   | 2.25                                        | 2.25 | 2.75 | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                             |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                 |                 |                                      |                                                                                                 |
|-------------------------|---------------------------------------------------------------------------------|-----------------|--------------------------------------|-------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                         | Relevant<br>SDG | SDG<br>Description                   | Mapping Justification                                                                           |
| CO1                     | Understand fundamentals of FSO communication systems and optical devices.       | SDG4            | Quality Education                    | Supports quality education through understanding modern optical communication technologies.     |
| CO2                     | Analyze atmospheric effects and channel impairments in FSO links..              | SDG9            | Industry, Innovation, Infrastructure | Promotes innovation in reliable and efficient wireless communication infrastructure.            |
| CO3                     | Apply modulation and detection techniques for FSO performance analysis          | SDG9            | Industry, Innovation, Infrastructure | Enhances technical skills for performance analysis and advanced communication system design.    |
| CO4                     | Design and evaluate FSO systems for modern wireless communication applications. | SDG 11          | Sustainable Cities and Communities   | Contributes to smart and sustainable communication networks for future cities and applications. |

| DIGITAL SPEECH PROCESSING                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |             |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                          |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | U24EC801C | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                         |           |             |       |
| <b>CO1 :</b> analyze the speech production mechanism and apply appropriate digital models for the representation of speech signals<br><b>CO2 :</b> apply and evaluate time-domain techniques for speech signal analysis and pitch estimation<br><b>CO3 :</b> analyze and apply LPC and cepstrum techniques for speech processing<br><b>CO4 :</b> interpret the performance of speech processing systems in real-world voice-based applications                                           |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |             | 9 Hrs |
| <b>Fundamentals of Digital Speech Processing:</b> Introduction- speech signal, Digital speech processing-representation of speech signals, speech communication applications, Digital models for speech signal-process of speech production, the acoustic theory of speech production- sound propagation, vocal tract transfer function for vowels, excitation of sound in the vocal tract, digital models for speech signals-vocal tract, radiation, excitation and the complete model. |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |             | 9 Hrs |
| <b>Time Domain Models for Speech Processing:</b> Introduction, time dependent processing of speech, short time energy and average magnitude, short time average zero crossing rate, speech vs. silence discrimination using energy and zero crossings, the short time autocorrelation function, the short time average magnitude difference function, pitch period estimation using a parallel processing approach, pitch period estimation using the autocorrelation function.          |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |             | 9 Hrs |
| <b>Homomorphic Speech Processing:</b> Introduction, homomorphic systems for convolution-properties of the complex cepstrum, computational considerations, the complex cepstrum of speech, pitch detection, the homomorphic vocoder.<br><br><b>Linear predictive coding (LPC) of speech:</b> Introduction, basic principles of linear predictive analysis- the autocorrelation method, the covariance method. Application of LPC Parameters: Pitch detection using LPC parameters.        |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |             | 9 Hrs |
| <b>Digital Speech Processing for man-machine communication by voice:</b> Introduction, Voice response systems (Block diagram, general considerations in the design, applications), speaker recognition systems-speaker verification systems, speaker                                                                                                                                                                                                                                     |           |             |       |

identification systems, speech recognition systems- Isolated digit recognition system, continuous digit recognition system, large vocabulary word recognition system, A 3-mode speech communication system.

**TextBook(s):**

1. L.R Rabiner and R.W.Schafer, *Digital processing of speech signals*, Pearson education, New Delhi, 2009.(Chapters 1, 3, 4, 7 to 9)

**Reference Book(s):**

1. Ben Gold ,Nelson Morgan and Dan Ellis, *Speech and Audio Signal Processing: Processing and Perception of speech and music*, John Wiley & sons, Inc ,2<sup>nd</sup> edition.
2. Randy Goldberg and lance riek, *A practical handbook of speech coders*, CRC Press LLC, 2000.
3. Soumya sen, Anjan dutta and Niranjana dey, *Audio processing and speech recognition concepts, techniques and research overviews*, springer briefs in applied sciences and technology, computational intelligence.

**Web and Video link(s):**

ps://onlinecourses.nptel.ac.in/noc22\_ee117/preview; NPTEL Video Lecture on Dital Speech Processing by Prof. Shyamal Kumar Das Mandal, IIT Kharagpur.

| Course Articulation Matrix (CAM): |              |      |      | U24EC801C : DIGITAL SPEECH PROCESSING |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|--------------|------|------|---------------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |              | PO1  | PO2  | PO3                                   | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC801C.1  | 3    | 2    | 1                                     | 1    | 2    | –   | –   | –   | –   | –    | 1    | 2    | 2    |
| CO2                               | U24 EC801C.2 | 3    | 3    | 1                                     | 2    | 3    | –   | –   | –   | –   | –    | 1    | 2    | 2    |
| CO3                               | U24 EC801C.3 | 3    | 3    | 2                                     | 2    | 3    | –   | –   | –   | –   | –    | 2    | 3    | 3    |
| CO4                               | U24 EC801C.4 | 2    | 3    | 2                                     | 2    | 3    | 1   | –   | 1   | 2   | 1    | 2    | 3    | 2    |
| U24EC801C                         |              | 2.75 | 2.75 | 1.5                                   | 1.75 | 2.75 | 1   | -   | 1   | 2   | 1    | 1.5  | 2.5  | 2.25 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |              |      |      |                                       |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                       |                 |                                         |                                                                                                                                                             |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                               | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                       |
| CO1                     | analyze the speech production mechanism and apply appropriate digital models for the representation of speech signals | SDG 4           | Quality Education                       | Builds fundamental knowledge in speech signal processing, strengthening technical education and digital literacy required for modern engineering domains.   |
| CO2                     | apply and evaluate time-domain techniques for speech signal analysis and pitch estimation                             | SDG 9           | Industry, Innovation and Infrastructure | Develops analytical skills used in speech analytics, communication systems, and signal-based innovations such as voice interfaces and IoT-enabled systems.  |
| CO3                     | analyze and apply LPC and cepstrum techniques for speech processing                                                   | SDG 9           | Industry, Innovation and Infrastructure | Enables advanced algorithmic development (LPC, cepstrum) widely used in speech compression, coding, and AI-driven voice technologies, fostering innovation. |
| CO4                     | interpret the performance of speech processing systems in                                                             | SDG 3, SDG 9,   | Good Health & Well-being;               | Supports development of assistive technologies (speech recognition, voice                                                                                   |

| CO-SDG Alignment Matrix |                                                         |                 |                                                               |                                                                                                                                    |
|-------------------------|---------------------------------------------------------|-----------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i> | Relevant<br>SDG | SDG<br>Description                                            | Mapping Justification                                                                                                              |
|                         | real-world voice-based applications                     | SDG 10          | Industry, Innovation and Infrastructure; Reduced Inequalities | aids) improving healthcare accessibility and inclusion (e.g., for disabled users), while contributing to technological innovation. |

| <b>EMBEDDED AUTOMOTIVE SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                             |                  |                    |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                         |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                            | <b>U24EC801D</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                   | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                         | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                               |                  |                    |              |
| <b>CO1 :</b> Explain the fundamentals and architecture of automotive embedded systems.<br><b>CO2 :</b> Analyse automotive sensors, actuators, and communication protocols used in vehicles<br><b>CO3 :</b> Apply automotive software architecture and RTOS concepts in embedded automotive systems.<br><b>CO4 :</b> Evaluate advanced automotive embedded applications including EVs and ADAS. |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                  |                  |                    | <b>9 Hrs</b> |
| <b>Introduction to Automotive Embedded Systems:</b> Introduction to automotive electronics, evolution of automotive systems, embedded system fundamentals, real-time systems, Electronic Control Units (ECUs), automotive microcontrollers, hardware and software components, automotive system architecture and design challenges.                                                            |                  |                    |              |
|                                                                                                                                                                                                                                                                                                                                                                                                |                  |                    | <b>9 Hrs</b> |
| <b>Automotive Sensors, Actuators and Communication Protocols:</b> Automotive sensors: temperature, pressure, speed, position and proximity sensors, actuators and interfacing techniques, signal conditioning circuits, CAN, LIN, FlexRay, Automotive Ethernet, diagnostics and fault handling.                                                                                                |                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                |                  |                    | <b>9 Hrs</b> |
| <b>Automotive Software Architecture:</b> Automotive software development process, layered software architecture, AUTOSAR fundamentals, RTOS concepts, task scheduling, memory management, software testing and validation, model-based development, functional safety standards.                                                                                                               |                  |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                 |                  |                    | <b>9 Hrs</b> |
| <b>Advanced Automotive Embedded Applications:</b> Engine management systems, anti-lock braking systems (ABS), airbag systems, Advanced Driver Assistance Systems (ADAS), infotainment systems, electric and hybrid vehicle embedded systems, battery management systems, autonomous vehicle concepts, automotive cybersecurity and future trends                                               |                  |                    |              |
| <b><u>TextBook(s):</u></b> <ol style="list-style-type: none"> <li>1. Automotive Embedded Systems Handbook – Nicolas Navet and Francoise Simonot-Lion, CRC Press.</li> <li>2. Embedded Systems – Raj Kamal, McGraw Hill Education.</li> <li>3. Automotive Electronics Handbook – McGraw Hill Publications.</li> </ol>                                                                           |                  |                    |              |
| <b><u>Reference Book(s):</u></b>                                                                                                                                                                                                                                                                                                                                                               |                  |                    |              |

1. Real-Time Embedded Systems – Elsevier Publications.
2. Embedded System Design – Wiley Publications.
3. Electric Vehicle Technology Explained – Wiley Publications.

| Course Articulation Matrix (CAM): |             |     |     | U24EC801D: <b>EMBEDDED AUTOMOTIVE SYSTEMS</b> |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|-----------------------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1 | PO2 | PO3                                           | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC801D.1 | 3   | 2   | 1                                             | 1    | 2    | 1   | -   | -   | -   | -    | -    | 2    | 2    |
| CO2                               | U24EC801D.2 | 2   | 2   | 3                                             | 2    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC801D.3 | 2   | 2   | 3                                             | 3    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC801D.4 | 1   | 2   | 2                                             | 3    | 3    | 3   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC801D                         |             | 2   | 2   | 2.25                                          | 2.25 | 2.75 | 2   | -   | -   | -   | -    | 1.75 | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                               |      |      |     |     |     |     |      |      |      |      |

| CO–SDG Alignment Matrix |                                                                                          |              |                                      |                                                                                                                                                                                                       |
|-------------------------|------------------------------------------------------------------------------------------|--------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                  | Relevant SDG | SDG Description                      | Mapping Justification                                                                                                                                                                                 |
| CO1                     | Explain the fundamentals and architecture of automotive embedded systems.                | SDG4         | Quality Education                    | Provides knowledge of modern automotive technologies, embedded systems, ECUs, and real-time systems, thereby enhancing technical education and industry readiness..                                   |
| CO2                     | Analyse automotive sensors, actuators, and communication protocols used in vehicles      | SDG9         | Industry, Innovation, Infrastructure | Supports development of intelligent automotive communication networks and smart vehicle technologies, fostering innovation and sustainable industrial infrastructure.                                 |
| CO3                     | Apply automotive software architecture and RTOS concepts in embedded automotive systems. | SDG9         | Industry, Innovation, Infrastructure | Promotes innovation through the development of reliable automotive software systems, AUTOSAR-based architectures, and real-time embedded solutions used in modern transportation systems.             |
| CO4                     | Evaluate advanced automotive embedded applications including EVs and ADAS.               | SDG 11       | Sustainable Cities and Communities   | Contributes to sustainable transportation, smart mobility, electric vehicles, ADAS, and intelligent transportation systems that improve safety, efficiency, and sustainability in urban environments. |

| NATURAL LANGUAGE PROCESSING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |             |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | U24EC801E | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |             |       |
| <b>CO1 :</b> apply fundamental NLP methods—including morphological parsing, tokenization, edit distance, N-gram modeling, and smoothing—to analyze and model natural language statistically                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |             |       |
| <b>CO2 :</b> perform syntactic analysis using POS tagging techniques, formal grammars, CFG parsing algorithms, and probabilistic parsing models                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |             |       |
| <b>CO3 :</b> interpret and model linguistic meaning through semantic analysis, lexical resources, WSD, semantic role labeling, and discourse-level reference resolution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |             |       |
| <b>CO4 :</b> design and evaluate Transformer-based NLP models (e.g., BERT, GPT) for tasks like classification, NER, QA, and summarization using fine-tuning and transfer learning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |             | 9 Hrs |
| <b>Natural Language Processing:</b> Introduction to NLP, Finite-state morphological parsing, FSTs for morphological parsing, Lexicon-Free FSTs: the Porter Stemmer algorithm, Word and sentence tokenization, Minimum edit distance<br><br><b>N-Grams:</b> Counting words in corpora, Simple unsmoothed N-grams, Training & Test sets, Evaluating N-grams: Perplexity<br><br><b>Smoothing:</b> Laplace Smoothing, Interpolation, Kneser-Ney smoothing, Class-based N-grams                                                                                                                                                                                                   |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           |             | 9 Hrs |
| <b>Part-of-Speech tagging:</b> Rule-based Part-of-Speech tagging, MHH part-of-speech tagging, Transformation-based tagging, Evaluation and error analysis<br><b>Statistical Parsing :</b> Probabilistic CFGs (PCFGs), probabilistic CKY parsing of PCFGs, Problems with PCFGs, Improving PCFGs by splitting & merging, The Collins Parser, Evaluating Parsers                                                                                                                                                                                                                                                                                                                |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             | 9 Hrs |
| <b>Computational semantics:</b> Introduction, Syntax-driven semantic analysis, Semantic augmentations to CGFs rules, Lexical Semantics: Word Senses, Relations between senses, Case study – WordNet: a database of lexical relations, Event participants: Semantic roles and selectional restrictions, FrameNet,<br><b>Word Sense Disambiguation (WSD):</b> Supervised WSD, WSD evaluation, baselines, and ceilings, Minimally supervised WSD: Bootstrapping, Semantic role labeling<br><b>Computational discourse:</b> Reference resolution, Reference phenomenon, The Hobb's algorithm for pronominal anaphora resolution, Coreference resolution, Case study: ConceptNet. |           |             |       |

| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 9 Hrs |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>Transformer</b> - Word Vectors, Recurrent Neural Networks, Long Short-Term Memory, Encoder-Decoder, Attention mechanisms, Positional encoding, Pre-trained models - BERT and GPT, Transfer learning, Fine-tuning for tasks such as machine translation, Text generation, and summarization.                                                                                                                                                                                                                                                                                      |       |
| <b>TextBook(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| 1. Lewis Tunstall, Leandro von Werra, Thomas Wolf, <i>Natural Language Processing with Transformers</i> , Revised Edition, O'Reilly Media, 2022.                                                                                                                                                                                                                                                                                                                                                                                                                                    |       |
| <b>Reference Book(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| 1. Steven Bird, Ewan Klein and Edward Loper, <i>Natural Language Processing with Python</i> , 1st ed., O'Reilly Media Inc, 2009.<br>2. Roland R. Hausser, <i>Foundations of Computational Linguistics: Human-Computer communication in Natural Language</i> , 1st ed., MIT Press, 2011.<br>3. Annamalai Chockalingam, Ankur Patel, Shashank Verma, Tiffany Yeung. <i>A Beginner's Guide to Large Language Models</i> . Online link: <a href="https://www.amax.com/content/files/2024/03/llm-ebook-part1-1.pdf">https://www.amax.com/content/files/2024/03/llm-ebook-part1-1.pdf</a> |       |
| <b>Web and Video link(s):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |
| <a href="https://onlinecourses.nptel.ac.in/noc25_cs22/preview">https://onlinecourses.nptel.ac.in/noc25_cs22/preview</a> ; NPTEL Video Lecture on Deep Learning for Natural Language Processing Deep Learning for Natural Language Processing by Prof. Pawan Goyal, Professor of Computer Science and Engineering, IIT Kharagpur                                                                                                                                                                                                                                                     |       |

| Course Articulation Matrix (CAM): |             |      |      | U24EC801E :NATURAL LANGUAGE PROCESSING |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|------|----------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2  | PO3                                    | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC801E.1 | 2    | 2    | 2                                      | 2   | 1   | -   | 1   | 1   | 1   | -    | 2    | 1    | 1    |
| CO2                               | U24EC801E.2 | 3    | 3    | 3                                      | 3   | 1   | -   | 1   | 1   | 1   | -    | 2    | 1    | 1    |
| CO3                               | U24EC801E.3 | 3    | 3    | 2                                      | 3   | 1   | -   | 1   | 1   | 1   | -    | 2    | 1    | 1    |
| CO4                               | U24EC801E.4 | 3    | 3    | 3                                      | 3   | 1   | -   | 1   | 1   | 1   | -    | 2    | 1    | 1    |
| U24EC801E                         |             | 2.75 | 2.75 | 2.5                                    | 2.5 | 1   | -   | 1   | 1   | 1   | -    | 2    | 2    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |      |                                        |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                |                 |                                 |                                                                                                                                                                  |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                        | Relevant<br>SDG | SDG<br>Description              | Mapping Justification                                                                                                                                            |
| CO1                     | apply fundamental NLP methods—including morphological parsing, tokenization, edit distance, N-gram modeling, and smoothing—to analyze and model natural language statistically | SDG4            | Quality Education               | Core NLP techniques support development of language learning tools, automated evaluation systems, and educational content analysis, enhancing quality education. |
| CO2                     | perform syntactic analysis using POS tagging techniques, formal grammars, CFG parsing algorithms, and                                                                          | SDG8            | Decent Work and Economic Growth | Syntactic processing improves document automation, information systems, and enterprise applications, increasing productivity and supporting economic growth.     |

| CO-SDG Alignment Matrix |                                                                                                                                                                       |                 |                                         |                                                                                                                                                                                          |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                               | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                    |
|                         | probabilistic parsing models                                                                                                                                          |                 |                                         |                                                                                                                                                                                          |
| CO3                     | interpret and model linguistic meaning through semantic analysis, lexical resources, WSD, semantic role labeling, and discourse-level reference resolution            | SDG11           | Sustainable Cities and Communities      | Semantic understanding enables intelligent systems like chatbots, sentiment analysis, and public service tools that improve communication and urban services.                            |
| CO4                     | design and evaluate Transformer-based NLP models (e.g., BERT, GPT) for tasks like classification, NER, QA, and summarization using fine-tuning and transfer learning. | SDG9            | Industry, Innovation and Infrastructure | Transformer-based NLP drives innovation in AI systems such as conversational agents, automation, and large-scale text analytics, supporting advanced infrastructure and industry growth. |

| <b>CLOUD AND EDGE COMPUTING FOR IoT</b>                                                                                                                                                                                                                                                                                                                                                        |                  |                    |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                         |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                            | <b>U24EC801F</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                   | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                         | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                               |                  |                    |              |
| <b>CO1 :</b> Explain fundamentals of cloud computing, IoT architecture and virtualization technologies for connected systems.                                                                                                                                                                                                                                                                  |                  |                    |              |
| <b>CO2 :</b> Analyze edge and fog computing architectures, protocols and real-time IoT data processing techniques.                                                                                                                                                                                                                                                                             |                  |                    |              |
| <b>CO3:</b> Apply cloud platforms, containerization and IoT analytics tools for scalable smart applications.                                                                                                                                                                                                                                                                                   |                  |                    |              |
| <b>CO4:</b> Interpret security, AI-enabled edge intelligence and industrial IoT applications for smart infrastructure and sustainable systems.                                                                                                                                                                                                                                                 |                  |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                  |                  |                    | <b>9 Hrs</b> |
| <b>Introduction to Cloud Computing and IoT:</b> Evolution of Cloud Computing, Characteristics and service models (IaaS, PaaS, SaaS), Cloud deployment models, Virtualization and hypervisors, Internet of Things (IoT) architecture and components, Sensors and actuators, IoT communication technologies, MQTT and CoAP protocols, Cloud support for IoT applications                         |                  |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                 |                  |                    | <b>9 Hrs</b> |
| <b>Edge and Fog Computing for IoT:</b> Introduction to Edge and Fog Computing, Comparison of cloud, fog and edge paradigms, Edge devices and gateways, Real-time data processing, Distributed IoT architectures, Latency-aware computing, IoT middleware, Resource management and orchestration, Edge AI fundamentals, Industrial IoT (IIoT) applications.                                     |                  |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                |                  |                    | <b>9 Hrs</b> |
| <b>Cloud Platforms and IoT Analytics-</b> Cloud platforms for IoT: AWS IoT, Microsoft Azure IoT and Google Cloud IoT, Containers and Docker basics, Kubernetes fundamentals, Data storage and IoT databases, Big data analytics for IoT, Stream processing, IoT dashboards and visualization, Predictive analytics for smart systems.                                                          |                  |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                 |                  |                    | <b>9 Hrs</b> |
| <b>Security, AI and Smart Applications</b> Security challenges in cloud and edge computing, Authentication and access control, Blockchain for IoT security, AI-enabled edge intelligence, Smart cities and smart healthcare applications, Intelligent transportation systems, Green computing and sustainable IoT infrastructure, Emerging trends in edge-cloud convergence.                   |                  |                    |              |
| <b>TextBook(s):</b> <ol style="list-style-type: none"> <li>1. Rajkumar Buyya, James Broberg and Andrzej Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2019.</li> <li>2. Kai Hwang, Geoffrey Fox and Jack Dongarra, Distributed and Cloud Computing, Morgan Kaufmann, 2018.</li> <li>3. Pethuru Raj and Anupama Raman, The Internet of Things: Enabling Technologies,</li> </ol> |                  |                    |              |

Platforms and Use Cases, CRC Press, 2017

**Reference Book(s):**

1. David Hanes et al., IoT Fundamentals: Networking Technologies, Protocols and Use Cases for IoT, Cisco Press, 2017.
2. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2018.
3. Michael J. Kavis, Architecting the Cloud, Wiley, 2020.

**Web and Video link(s):**

1. <https://nptel.ac.in/> - NPTEL courses on Cloud Computing and IoT.
2. <https://aws.amazon.com/iot/> - AWS IoT learning resources.
3. <https://azure.microsoft.com/en-in/services/iot-hub/> - Microsoft Azure IoT tutorials.
4. <https://kubernetes.io/docs/home/> - Kubernetes official documentation.

| Course Articulation Matrix (CAM): |             |      |      | U24EC801F: CLOUD AND EDGE COMPUTING FOR IoT |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|------|---------------------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2  | PO3                                         | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC801F.1 | 2    | 2    | 1                                           | -    | 1    | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO2                               | U24EC801F.2 | 3    | 2    | 2                                           | 2    | 1    | -   | 1   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC801F.3 | 2    | 3    | 2                                           | 2    | 2    | -   | 1   | -   | 1   | -    | 2    | 2    | 2    |
| CO4                               | U24EC801F.4 | 2    | 2    | 2                                           | 1    | 1    | -   | 1   | -   | -   | -    | 3    | 2    | 2    |
| U24EC801F                         |             | 2.25 | 2.25 | 1.75                                        | 1.65 | 1.25 | -   | 1   | -   | 1   | -    | 2.25 | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |      |                                             |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                               |                 |                                         |                                                                                                      |
|-------------------------|---------------------------------------------------------------|-----------------|-----------------------------------------|------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>       | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                |
| CO1                     | Explain fundamentals of cloud computing and IoT architecture. | SDG9            | Industry, Innovation and Infrastructure | Cloud and IoT technologies strengthen digital infrastructure and industrial innovation.              |
| CO2                     | Analyze edge and fog computing architectures and protocols.   | SDG11           | Sustainable Cities and Communities      | Edge computing supports real-time smart city and industrial automation systems.                      |
| CO3                     | Apply cloud platforms and IoT analytics tools.                | SDG8            | Decent Work and Economic Growth         | Industrial IoT and analytics improve productivity, employability and digital transformation.         |
| CO4                     | Interpret security and AI-enabled smart IoT applications.     | SDG9            | Industry, Innovation and Infrastructure | Secure and intelligent IoT systems enable sustainable industrial and smart infrastructure solutions. |

| MEMS and NEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                    |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------|--------------|
| <b>Class:</b> B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | U24EC802A | <b>Credits:</b>    | 3            |
| <b>Hours/Week (L-T-P-E):</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2-1-0-3   | <b>CIE:</b>        | 60%          |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 36Hrs     | <b>ESE:</b>        | 40%          |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                  |           |                    |              |
| <b>CO1 :</b> Interpret the basics of micro/nano electromechanical systems including their applications and advantages<br><b>CO2 :</b> Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA<br><b>CO3 :</b> Analyze the key performance aspects of electromechanical transducers including sensors and actuators<br><b>CO4 :</b> Comprehend the theoretical foundations of quantum mechanics and Nano systems |           |                    |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                    | <b>9 Hrs</b> |
| <b>Overview of MEMS and Microsystems:</b> New trends in Engineering and Science: Micro and Nano scale systems Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electro mechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals                                                                                                     |           |                    |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                    | <b>9 Hrs</b> |
| <b>Microsystems fabrication processes:</b> Photolithography, Ion Implantation, Diffusion, and Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating. Etching techniques: Dry and wet etching, electrochemical etching. Micromachining: Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology.                                                                                                                                                      |           |                    |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                    | <b>9 Hrs</b> |
| <b>MEMS Sensors:</b> Design of Acoustic wave sensors, Biomedical Sensors and Bio Sensor, Chemical Sensors, Optical Sensors, Pressure Sensors and Thermal Sensors.<br><br><b>Micro Actuators:</b> Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps.                                                    |           |                    |              |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |                    | <b>9 Hrs</b> |
| <b>Nanosystems, Quantum Mechanics, and Mathematical Models:</b> Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics, Schrödinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and Their Quantization, Molecular Wires and                                                                                                                                                                                |           |                    |              |

|                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Molecular Circuits.                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>TextBook(s):</b> <ol style="list-style-type: none"> <li>1. Tai Ran Hsu, MEMS and Microsystems Design and Manufacture ,TataMcraw Hill, 2002. (Chapter 2, 8 and 9)</li> <li>2. Sergey Edward Lyshevski, MEMS and NEMS: Systems, Devices, and Structures, CRC Press, 2002 (Chapter 1 and 6)</li> </ol>                                                                                                      |
| <b>Reference Book(s):</b> <ol style="list-style-type: none"> <li>1. Marc Madou, "Fundamentals of Micro fabrication", CRC press</li> <li>2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006</li> <li>3. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers,2001</li> <li>4. Chang Liu, —Foundations of MEMSII , Pearson education India limited, 2006</li> </ol> |
| <b>Web and Video link(s):</b><br><a href="https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee63">ps://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee63</a> , NPTEL Video Lectures on A Brief Introduction of Micro-sensor- introduction by By Prof. Santanu Talukder, IISER Bhopal.                                                                                                        |

| Course Articulation Matrix (CAM):    |             |          |             | U24EC802A :MEMs and NEMs |          |          |     |     |     |     |      |             |          |          |
|--------------------------------------|-------------|----------|-------------|--------------------------|----------|----------|-----|-----|-----|-----|------|-------------|----------|----------|
| CO                                   |             | PO1      | PO2         | PO3                      | PO4      | PO5      | PO6 | PO7 | PO8 | PO9 | PO10 | PO11        | PSO1     | PSO2     |
| CO1                                  | U24EC802A.1 | 1        | 1           | 1                        | 1        | -        | -   | -   | -   | -   | -    | 1           | 2        | 1        |
| CO2                                  | U24EC802A.2 | 1        | 2           | 2                        | 1        | 1        | -   | -   | -   | -   | -    | 1           | 2        | 1        |
| CO3                                  | U24EC802A.3 | 1        | 2           | 2                        | 1        | -        | -   | -   | -   | -   | -    | 1           | 2        | 1        |
| CO4                                  | U24EC802A.4 | 1        | 2           | 2                        | 1        | 1        | -   | -   | -   | -   | -    | 2           | 2        | 1        |
| <b>U24EC802A</b>                     |             | <b>1</b> | <b>1.75</b> | <b>1.75</b>              | <b>1</b> | <b>1</b> | -   | -   | -   | -   | -    | <b>1.25</b> | <b>2</b> | <b>1</b> |
| <b>3 - HIGH, 2 - MEDIUM, 1 - LOW</b> |             |          |             |                          |          |          |     |     |     |     |      |             |          |          |

| CO-SDG Alignment Matrix |                                                                                                                                                           |                 |                                         |                                                                                                                                                                                                                                              |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                   | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                                                                        |
| CO1                     | Interpret the basics of micro/nanoelectromechanical systems including their applications and advantages                                                   | SDG 9           | Industry, Innovation and Infrastructure | MEMS and NEMS technologies drive innovation in advanced electronics, healthcare devices, automotive systems, and communication technologies, supporting sustainable industrial growth and modern infrastructure development.                 |
| CO2                     | Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA | SDG 12          | Responsible Consumption and Production  | Microfabrication processes enable precise material utilization, reduced waste generation, and efficient manufacturing techniques, promoting sustainable production practices in semiconductor and microdevice industries.                    |
| CO3                     | Analyze the key performance aspects of electromechanical transducers including sensors and actuators                                                      | SDG 3           | Good Health and Well-being              | Sensors and actuators developed using MEMS/NEMS technologies are widely used in biomedical devices, wearable health monitoring systems, diagnostic instruments, and smart healthcare applications, improving quality healthcare delivery and |

| CO-SDG Alignment Matrix |                                                                              |                 |                    |                                                                                                                                                                                                                          |
|-------------------------|------------------------------------------------------------------------------|-----------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                      | Relevant<br>SDG | SDG<br>Description | Mapping Justification                                                                                                                                                                                                    |
|                         |                                                                              |                 |                    | patient safety.                                                                                                                                                                                                          |
| CO4                     | Comprehend the theoretical foundations of quantum mechanics and Nano systems | SDG 4           | Quality Education  | Understanding quantum mechanics and nanosystems equips students with advanced scientific knowledge and emerging technological skills, fostering higher education, research capability, and innovation-oriented learning. |

## 5G AND BEYOND 5G WIRELESS COMMUNICATIONS

|                                        |                  |                    |            |
|----------------------------------------|------------------|--------------------|------------|
| <b>Class:</b> B. Tech. VIII – Semester |                  | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC802B</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** Explain the evolution, architecture, services and standards of 5G wireless communication systems.
- CO2 :** Analyze advanced physical layer technologies such as OFDM, Massive MIMO, beamforming and mmWave communications used in 5G networks.
- CO3 :** Apply multiple access techniques, cognitive radio and intelligent spectrum management methods in modern wireless communication systems.
- CO4 :** Interpret Beyond-5G applications, AI/ML enabled wireless networks and emerging 6G technologies.

### UNIT-I

**9 Hrs**

**Introduction to 5G Wireless Systems:** Evolution of wireless communication systems: 1G to 5G, Requirements and challenges of 5G networks, LTE, LTE-Advanced and LTE-A Pro overview, 5G NR architecture and protocol stack, Service categories: eMBB, URLLC and mMTC, Spectrum allocation and IMT-2020 standards, Small cells and heterogeneous networks.

### UNIT-II

**9 Hrs**

**Advanced PHY Layer Technologies:** OFDM fundamentals and limitations, Advanced waveforms: FBMC, GFDM and UFMC, Massive MIMO systems, Beamforming techniques, Hybrid beamforming, Millimeter-wave (mmWave) communications, 5G channel models, Carrier aggregation and bandwidth parts.

### UNIT-III

**9 Hrs**

**Multiple Access and Spectrum Management:** Non-Orthogonal Multiple Access (NOMA), SCMA, Power-domain NOMA, Resource allocation techniques, Interference management, Cognitive radio networks, Dynamic spectrum sharing, Spectrum sensing techniques.

### UNIT-IV

**9 Hrs**

**Beyond 5G and Emerging Technologies:** Device-to-Device (D2D) communication, Internet of Things (IoT) in 5G, Vehicle-to-Everything (V2X) communication, UAV-assisted communication, Edge computing and network slicing, AI/ML in wireless communication, Reconfigurable Intelligent Surfaces (RIS), Introduction to 6G technologies, Security challenges in 5G/B5G systems.

### TextBook(s):

1. Dahlman E., Parkvall S., and Skold J., *5G NR: The Next Generation Wireless Access Technology*, 2nd ed., Academic Press, 2020.
2. Vaezi M., Ding Z., and Poor H. V., *Multiple Access Techniques for 5G Wireless Networks and Beyond*, Springer, 2019.

**Reference Book(s):**

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2005.
2. Andreas F. Molisch, *Wireless Communications: From Fundamentals to Beyond 5G*, 3rd ed., Wiley, 2022.
3. Mohammad A. Matin, *Spectrum Access and Management for Cognitive Radio Networks*, Springer, 2017.

**Web and Video link(s):**

1. <https://onlinecourses.nptel.ac.in/> NPTEL Video Lectures on Wireless Communication and 5G Technologies by IIT Professors.
2. <https://www.qualcomm.com/5g/what-is-5g> Qualcomm Tutorial on 5G Fundamentals, Architecture and Applications.
3. <https://www.mathworks.com/videos/series/understanding-the-5g-nr-standard.html> MATLAB and Simulink Video Series on 5G NR Standard and PHY Layer Technologies.
4. <https://www.3gpp.org/> Official 3GPP Website for 5G NR Standards and Releases.

| Course Articulation Matrix (CAM): |             |      |      | U24EC802B: 5G AND BEYOND 5G WIRELESS COMMUNICATIONS |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|------|------|-----------------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |             | PO1  | PO2  | PO3                                                 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC802B.1 | 2    | 2    | 1                                                   | -   | -   | -   | -   | -   | 1   | -    | 2    | 2    | -    |
| CO2                               | U24EC802B.2 | 3    | 2    | 2                                                   | 2   | 1   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO3                               | U24EC802B.3 | 2    | 3    | 2                                                   | 2   | 1   | -   | -   | -   | -   | -    | 2    | -    | 3    |
| CO4                               | U24EC802B.4 | 2    | 2    | 2                                                   | -   | 1   | -   | 1   | -   | -   | -    | 3    | -    | 3    |
| U24EC802B                         |             | 2.25 | 2.25 | 1.75                                                | 2   | 1   | -   | 1   | -   | 1   | -    | 2.33 | 2.5  | 3    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |      |      |                                                     |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                         |                 |                                         |                                                                                                                                                        |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                 | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                  |
| CO1                     | Explain the evolution, architecture, services and standards of 5G wireless communication systems.                                       | SDG9            | Industry, Innovation and Infrastructure | 5G wireless communication technologies support modern digital infrastructure, smart connectivity and innovation in communication systems.              |
| CO2                     | Analyze advanced physical layer technologies such as OFDM, Massive MIMO, beamforming and mmWave communications used in 5G networks.     | SDG9            | Industry, Innovation and Infrastructure | Advanced PHY layer technologies improve spectral efficiency, network capacity and high-speed communication infrastructure for future wireless systems. |
| CO3                     | Apply multiple access techniques, cognitive radio and intelligent spectrum management methods in modern wireless communication systems. | SDG7            | Affordable and Clean Energy             | Efficient spectrum utilization and intelligent resource allocation reduce energy consumption and improve sustainable wireless communication systems.   |
| CO4                     | Interpret Beyond-5G                                                                                                                     | SDG11           | Sustainable                             | AI-enabled 5G/6G technologies support smart                                                                                                            |

| CO-SDG Alignment Matrix |                                                                             |                 |                        |                                                                                                          |
|-------------------------|-----------------------------------------------------------------------------|-----------------|------------------------|----------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                     | Relevant<br>SDG | SDG<br>Description     | Mapping Justification                                                                                    |
|                         | applications, AI/ML enabled wireless networks and emerging 6G technologies. |                 | Cities and Communities | cities, intelligent transportation, IoT applications and sustainable urban communication infrastructure. |

## DSP PROCESSORS AND ARCHITECTURE

|                                        |                  |                    |            |
|----------------------------------------|------------------|--------------------|------------|
| <b>Class:</b> B. Tech. VIII – Semester |                  | <b>Branch:</b> ECE |            |
| <b>Course Code:</b>                    | <b>U24EC802C</b> | <b>Credits:</b>    | <b>3</b>   |
| <b>Hours/Week (L-T-P-E):</b>           | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b> |
| <b>Total Number of Teaching Hours:</b> | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b> |

### Course Learning Outcomes (COs)

*After completion of this course, the students should be able to,*

- CO1 :** analyse the fundamentals of programmable DSP systems, DSP signal representations, and computational accuracy issues in DSP implementations
- CO2 :** interpret the architectural features, computational building blocks, memory organization, and addressing modes of programmable DSP processors
- CO3 :** apply programming concepts, instruction sets, and pipeline operations of commercial DSP processors such as TMS320C54XX for DSP applications
- CO4 :** implement DSP algorithms including FIR, IIR, and FFT using programmable DSP processors and analyse DSP interfacing and application systems

### UNIT-I

**9 Hrs**

**Introduction:** Major features of programmable digital signal processors, a Digital signal-processing system, review of digital signal-processing fundamentals.

**Computational Accuracy in DSP Implementations:** Number formats for signals and coefficients in DSP systems, Dynamic range and precision, Sources of error in DSP Implementations, Sources of error in DSP implementations, A/D conversion errors, DSP computational errors, D/A conversion errors

### UNIT-II

**9 Hrs**

**Architectures for Programmable DSP Devices:** Basic architectural features, DSP computational building blocks-multiplier, shifter, MAC unit, ALU, Bus architecture and memory, Data addressing capabilities-immediate addressing, register addressing, direct addressing, indirect addressing, special addressing modes, Address generation unit, Programmability and program execution, Speed issues- hardware architecture, parallelism, pipelining, system level parallelism and pipelining, Features for external interfacing.

### UNIT-III

**9 Hrs**

**Programmable Digital Signal Processors:** Commercial digital signal processing devices, Architecture of TMS320C25, Motorola DSP 56000, ADSP 2100, TMS320C54XX signal processors, Data addressing modes of TMS320C54XX processors, Memory space of processors, Program control, TMS320C54XX instructions and programming, On-Chip peripherals, Interrupts of TMS320C54XX processors, Pipeline operation of TMS320C54XX processors.

### UNIT-IV

**9 Hrs**

**Implementations of Basic DSP Algorithms:** The Q-notation, FIR filters, IIR filters, Implementation of FFT algorithms -An 8-point FFT implementation on the

TMS320C54xx

**Interfacing Memory and Parallel I/O Peripherals to Programmable DSP Devices:** Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O

**Applications of Programmable DSP Devices:** DSP-based biotelemetry receiver, a speech processing system, an image processing system

**TextBook(s):**

1. Avatar Singh and S. Srinivasan, *Digital Signal Processing-Implementations using DSP Microprocessors with examples from TMS320C54XX*, CENGAGE Learning, 2004. (Chapters 1 to 5, 7 to 9, 11)

**Reference Book(s):**

1. Peter Pirsch, *Architectures for Digital Signal Processing*, John Wiley, 2007
2. Ifeachor E. C., Jervis B. W, *Digital Signal Processing: A practical approach*, Pearson Education, PHI, 2002
3. B Venkataramani and M Bhaskar, *Digital Signal Processors*, TMH, 2002

**Web and Video link(s):**

ps://nptel.ac.in/courses/108106149; NPTEL Video Lecture on Mapping Signal Processing Algorithms to DSP Architectures by Prof. Nitin Chandrachoodan, Dept of Electrical Engineering, IIT Madras.

| Course Articulation Matrix (CAM): |              |     |      | U24EC802C: DSP PROCESSORS AND ARCHITECTURES |      |     |     |     |     |     |      |      |      |      |
|-----------------------------------|--------------|-----|------|---------------------------------------------|------|-----|-----|-----|-----|-----|------|------|------|------|
| CO                                |              | PO1 | PO2  | PO3                                         | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC802C.1  | 3   | 2    | 1                                           | -    | 1   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO2                               | U24 EC802C.2 | 3   | 3    | 2                                           | 1    | 3   | -   | -   | -   | -   | -    | -    | 3    | 2    |
| CO3                               | U24 EC802C.3 | 3   | 3    | 3                                           | 2    | 3   | -   | -   | -   | 1   | 1    | -    | 3    | 3    |
| CO4                               | U24 EC802C.4 | 3   | 3    | 3                                           | 2    | 3   | -   | -   | -   | 1   | 1    | -    | 3    | 3    |
| U24EC802C                         |              | 3   | 2.75 | 2.25                                        | 1.67 | 2.5 |     |     |     | 1   | 1    |      | 2.75 | 2.25 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |              |     |      |                                             |      |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                |                 |                                         |                                                                                                                                                                                      |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                        | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                |
| CO1                     | Analyze the fundamentals of programmable DSP systems, DSP signal representations, and computational accuracy issues in DSP implementations     | SDG 4           | Quality Education                       | Develops fundamental knowledge and technical competency in DSP systems and signal processing concepts essential for quality engineering education and lifelong learning.             |
| CO2                     | Interpret the architectural features, computational building blocks, memory organization, and addressing modes of programmable DSP processors. | SDG 9           | Industry, Innovation and Infrastructure | Enhances understanding of advanced DSP architectures and embedded processing technologies that contribute to innovation in digital communication and intelligent electronic systems. |
| CO3                     | Apply programming concepts, instruction sets, and pipeline                                                                                     | SDG 9           | Industry, Innovation and                | Promotes industry-relevant programming and processor                                                                                                                                 |

| CO-SDG Alignment Matrix |                                                                                                                                             |                 |                                         |                                                                                                                                                         |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                     | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                   |
|                         | operations of commercial DSP processors such as TMS320C54XX for DSP applications.                                                           |                 | Infrastructure                          | implementation skills required for professional employment and advanced industrial applications.                                                        |
| CO4                     | Implement DSP algorithms including FIR, IIR, and FFT using programmable DSP processors and analyze DSP interfacing and application systems. | SDG 9           | Industry, Innovation and Infrastructure | Supports development of efficient DSP-based technological solutions for real-time communication, biomedical, speech, and image processing applications. |

| <b>ROBOTICS AND INTELLIGENT SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                      |                  |                    |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|--------------|
| <b>Class:</b> B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                       |                  | <b>Branch:</b> ECE |              |
| <b>Course Code:</b>                                                                                                                                                                                                                                                                                                                                                                          | <b>U24EC802D</b> | <b>Credits:</b>    | <b>3</b>     |
| <b>Hours/Week (L,T,P, E):</b>                                                                                                                                                                                                                                                                                                                                                                | <b>2-1-0-3</b>   | <b>CIE:</b>        | <b>60%</b>   |
| <b>Total Number of Teaching Hours:</b>                                                                                                                                                                                                                                                                                                                                                       | <b>36Hrs</b>     | <b>ESE:</b>        | <b>40%</b>   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                             |                  |                    |              |
| <b>CO1 :</b> Explain the fundamentals of mobile robots, wheel configurations, locomotion mechanisms and kinematic models of wheeled mobile robots.                                                                                                                                                                                                                                           |                  |                    |              |
| <b>CO2 :</b> Analyze robot motion planning techniques, trajectory generation methods and various robot control strategies used in robotic systems.                                                                                                                                                                                                                                           |                  |                    |              |
| <b>CO3 :</b> Apply motion planning and navigation algorithms for autonomous robot navigation in structured and unstructured environments.                                                                                                                                                                                                                                                    |                  |                    |              |
| <b>CO4 :</b> Illustrate localization, mapping and robot vision techniques used in intelligent robotic systems and autonomous applications.                                                                                                                                                                                                                                                   |                  |                    |              |
| <b>UNIT - I</b>                                                                                                                                                                                                                                                                                                                                                                              |                  |                    | <b>9 Hrs</b> |
| <b>Mobile Robots:</b> Introduction to Wheeled Robots, Classification of wheels, Fixed wheel, Centered Oriented Wheel, Off-centered oriented wheel, Swedish wheel, Mobile robot locomotion, Differential Wheel, Tricycle, Synchronous drive, Omni-directional, Ackerman Steering, Kinematics models of WMR.                                                                                   |                  |                    |              |
| <b>UNIT - II</b>                                                                                                                                                                                                                                                                                                                                                                             |                  |                    | <b>9 Hrs</b> |
| <b>Robot Motion Control :</b> Robot Motion Planning, Path Planning, Geometric path, Obstacle avoidance, Shortest path, Trajectory planning, Boundary conditions, Control Methods – Conventional Joint PID control, Computed torque, Nonlinear feedback, Adaptive Control, Variable Structure Control.                                                                                        |                  |                    |              |
| <b>UNIT - III</b>                                                                                                                                                                                                                                                                                                                                                                            |                  |                    | <b>9 Hrs</b> |
| <b>Motion Planning and Navigation:</b> Basics, Configuration Space, Obstacles, Motion Planning Methods, Roadmap Approaches, Visibility graphs, Voronoi diagram, Cell Decomposition, Trapezoidal Decomposition, Potential Fields, Bug Algorithms, RRT.                                                                                                                                        |                  |                    |              |
| <b>UNIT - IV</b>                                                                                                                                                                                                                                                                                                                                                                             |                  |                    | <b>9 Hrs</b> |
| <b>Localization, Mapping and Robot Vision: Localization and Mapping:</b> Introduction to localization, Challenges in localization, Localization and navigation, Mapping: map representation, Indoor and outdoor mapping, SLAM, Bayes rule, Passive and active Beacons sensors, Global Positioning System (GPS), DGPS, Laser Range Scanner.                                                   |                  |                    |              |
| <b>Robot Vision:</b> Introduction, Image acquisition, Illumination Techniques, Image Conversion, Frame Buffers and Grabbers, Image sampling and Quantization, Basic Relationship between pixels, Image enhancement in Spatial and Frequency domain, Image Processing and Analysis, Data Reduction: Edge detection, Feature Extraction and Object Recognition Algorithms and its applications |                  |                    |              |

**TextBook(s):**

1. Robotics: Control, Sensing, Vision and Intelligence, McGraw,Hill, 1987.
2. Sensors for Mobile Robots: Theory and Applications, A.K. Peters Ltd., 1995.
3. Introduction to Autonomous Mobile Robots, MIT Press, 2004.
4. Robotics and Automation Handbook, CRC Press, 2005.

**Reference Book(s):**

1. Where Am I? Sensors and Methods for Mobile Robot Positioning, University of Michigan, 1996.
2. Applying Machine Vision, John Wiley & Sons, 1988.
3. Robotics and Image Processing, Tata McGraw,Hill, 1995.

| Course Articulation Matrix (CAM): |             |     |     | U24EC802D: ROBOTICS AND INTELLIGENT SYSTEMS |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|---------------------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1 | PO2 | PO3                                         | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC802D.1 | 3   | 2   | 1                                           | 1    | 2    | 1   | -   | -   | -   | -    | -    | 2    | 2    |
| CO2                               | U24EC802D.2 | 2   | 2   | 3                                           | 2    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC802D.3 | 2   | 2   | 3                                           | 3    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC802D.4 | 1   | 2   | 2                                           | 3    | 3    | 3   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC802D                         |             | 2   | 2   | 2.25                                        | 2.25 | 2.75 | 2   | -   | -   | -   | -    | 1.75 | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 , LOW     |             |     |     |                                             |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                           |                 |                                      |                                                                                                                                                     |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                   | Relevant<br>SDG | SDG<br>Description                   | Mapping Justification                                                                                                                               |
| CO1                     | Explain the fundamentals of mobile robots, locomotion mechanisms, wheel configurations, and kinematic models.             | SDG4            | Quality Education                    | Supports quality education through the study of modern robotic systems, locomotion mechanisms, and intelligent automation technologies.             |
| CO2                     | Analyze robot motion planning, trajectory generation, and control strategies for robotic systems.                         | SDG9            | Industry, Innovation, Infrastructure | Promotes innovation in robotics and automation through advanced motion planning and intelligent control techniques used in industrial applications. |
| CO3                     | Apply localization, mapping, and navigation techniques for autonomous robot operation.                                    | SDG9            | Industry, Innovation, Infrastructure | Enhances the development of autonomous robotic systems for intelligent transportation, industrial automation, and smart infrastructure              |
| CO4                     | Illustrate robot vision, image processing, and intelligent perception techniques used in autonomous robotic applications. | SDG 11          | Sustainable Cities and Communities   | Contributes to smart city applications through intelligent perception, autonomous navigation, surveillance, healthcare, and service robotics.       |

| PREDICTIVE ANALYTICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |             |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | U24EC802E | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 36 Hrs    | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |             |       |
| <b>CO1 :</b> explain the predictive modeling process, data transformations, predictor removal, and binning techniques.<br><b>CO2 :</b> apply quantitative performance measures, variance-bias trade-off, linear regression, partial least squares, principal component regression, and penalized models for regression-based predictive modeling<br><b>CO3 :</b> analyze classification model performance using class predictions, probabilities, equivocal zones, predictor importance, and measurement errors<br><b>CO4 :</b> build time series models including stationarity tests, differencing, AR, MA, ARMA, and ARIMA models, and perform forecasting using Python. |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             | 9 Hrs |
| <b>Introduction to Predictive Modeling:</b> A short tour of the predictive modeling process, themes, Data Transformations for Individual Predictors, Data Transformations for multiple Predictors, dealing with missing data, Removing Predictors, adding predictors, binning predictors.                                                                                                                                                                                                                                                                                                                                                                                  |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |             | 9 Hrs |
| <b>Measuring Performance in Regression Models:</b> Quantitative Measures of Performance, The Variance-Bias Trade-off, Quantitative Structure-Activity Relationship Modeling, Linear Regression for Solubility Data, Partial Least Squares (PLS), Principal Component Regression (PCR) and PLS for Solubility Data, Algorithmic Variations of PLS, Penalized Models.                                                                                                                                                                                                                                                                                                        |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |             | 9 Hrs |
| <b>Measuring Performance in Classification Models:</b> Class Predictions, Well-Calibrated Probabilities, Class Probabilities, Equivocal Zones, Evaluating Predicted Classes, and Evaluating Class Probabilities. <b>Measuring Predictor Importance:</b> Numeric Outcomes, Categorical Outcomes, and Other Approaches. <b>Measuring Predictor Error:</b> Type III Errors, Measurement Error in the Outcome, and Measurement Error in the Predictors.                                                                                                                                                                                                                        |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |             | 9 Hrs |
| <b>Time Series Analysis and Forecasting with Python:</b> The Concept of Time Series, Stationary Time Series Models: Backshift Operator, Differencing, Stationarity Test, Moving Average Models, Autoregressive Models, Autoregressive Moving Average Models, ARMA and ARIMA Modeling and Forecasting.                                                                                                                                                                                                                                                                                                                                                                      |           |             |       |
| <b>TextBook(s):</b> <ol style="list-style-type: none"> <li>1. Max Kuhn, Kjell Johnson, <i>Applied Predictive Modeling</i>, Springer, 1st edition, 2013, New York.</li> <li>2. Changquan Huang, Alla Petukhina, <i>Applied Time Series Analysis and Forecasting with</i></li> </ol>                                                                                                                                                                                                                                                                                                                                                                                         |           |             |       |

*Python*, Springer, 1st edition, 2022, Cham.

**Reference Book(s):**

1. Kuhn, Max, and Kjell Johnson. *Feature Engineering and Selection: A Practical Approach for Predictive Models*. 2019, CRC Press.
2. Miller, James D., and Rui Miguel Forte. *Mastering Predictive Analytics with R*. 2017, Packt Publishing Ltd.

**Web and Video link(s):**

<https://www.youtube.com/watch?v=suIMSpBjiyM&list=PLyqSpQzTE6M8p6r5De8t34EChIT683NcB>; NPTEL Video Lecture on Predictive Analytics - Regression and Classification by Prof. Sourish Das, Associate Professor of Chennai Mathematical Institute, Madras.

| Course Articulation Matrix (CAM): |             |     |     | U24EC802E :PREDICTIVE ANALYTICS |     |      |     |     |     |      |      |      |      |      |
|-----------------------------------|-------------|-----|-----|---------------------------------|-----|------|-----|-----|-----|------|------|------|------|------|
| CO                                |             | PO1 | PO2 | PO3                             | PO4 | PO5  | PO6 | PO7 | PO8 | PO9  | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC802E.1 | 3   | 2   | 1                               | 2   | 3    | -   | -   | -   | -    | 1    | 1    | 2    | 2    |
| CO2                               | U24EC802E.2 | 3   | 3   | 2                               | 3   | 3    | -   | -   | -   | 1    | 1    | 1    | 3    | 3    |
| CO3                               | U24EC802E.3 | 3   | 3   | 2                               | 3   | 2    | -   | -   | -   | 2    | -    | 1    | 3    | 2    |
| CO4                               | U24EC802E.4 | 3   | 3   | 3                               | 3   | 3    | -   | -   | -   | 2    | 1    | 1    | 3    | 3    |
| U24EC802E                         |             | 3   | 3   | 2.75                            | 2   | 2.75 | -   | -   | -   | 1.67 | 1.25 | 0.75 | 1    | 2.75 |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                 |     |      |     |     |     |      |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                           |                 |                                         |                                                                                                                                                                                                                          |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                                                   | Relevant<br>SDG | SDG<br>Description                      | Mapping Justification                                                                                                                                                                                                    |
| CO1                     | explain the predictive modeling process, data transformations, predictor removal, and binning techniques                                                                                                  | SDG4            | Quality Education                       | Understanding predictive modeling fundamentals and data preprocessing equips students with essential analytical and digital skills, promoting quality education and lifelong learning                                    |
| CO2                     | apply quantitative performance measures, variance-bias trade-off, linear regression, partial least squares, principal component regression, and penalized models for regression-based predictive modeling | SDG9            | Industry, Innovation and Infrastructure | Regression models are core to industrial analytics, automation, and intelligent decision-making systems. This directly supports innovation and infrastructure development                                                |
| CO3                     | analyze classification model performance using class predictions, probabilities, equivocal zones, predictor importance, and measurement errors                                                            | SDG11           | Sustainable Cities and Communities      | Classification performance evaluation is critical for smart city applications such as traffic anomaly detection, urban infrastructure monitoring, and public safety systems. This supports sustainable urban development |
| CO4                     | build time series models including stationarity tests,                                                                                                                                                    | SDG7            | Affordable and Clean Energy             | Time series forecasting is essential for renewable energy integration, smart                                                                                                                                             |

| CO-SDG Alignment Matrix |                                                                                     |                 |                    |                                                                                                          |
|-------------------------|-------------------------------------------------------------------------------------|-----------------|--------------------|----------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                             | Relevant<br>SDG | SDG<br>Description | Mapping Justification                                                                                    |
|                         | differencing, AR, MA, ARMA, and ARIMA models, and perform forecasting using Python. |                 |                    | grid load prediction, and energy efficiency – directly supporting affordable and clean energy solutions. |

| INDUSTRIAL IoT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |             |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-------|
| Class: B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |           | Branch: ECE |       |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | U24EC802F | Credits:    | 3     |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2-1-0-3   | CIE:        | 60%   |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 36Hrs     | ESE:        | 40%   |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |             |       |
| <b>CO1 :</b> Explain the fundamentals of industrial IoT, their components, and technologies.<br><b>CO2 :</b> Explain sensor and their functionality and their use in industrial IoT.<br><b>CO3 :</b> Demonstrate the implementation and deployment challenges in Industrial IoT.<br><b>CO4 :</b> Analyse the applications of Internet of things in industries and learn to deploy a task accordingly.                                                                                                                                                                                                                                                                |           |             |       |
| UNIT-I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |             | 9 Hrs |
| <b>Introduction to Industrial Internet of Things:</b> Definition and Evolution of IIoT - Differentiating IIoT from IoT - Historical context and development - KeyComponents ofIIoT -Sensors andactuators - Connectivity technologies - Connectivity and Networking - Wireless Technologies - 5G in IIoT - LPWAN (Low-Power Wide-Area Network) - Network Topologies.                                                                                                                                                                                                                                                                                                  |           |             |       |
| UNIT-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |             | 9 Hrs |
| <b>Introduction to Sensor Technology:</b> Definition of Sensors and Transducers -Importance and Applications of Sensors - Classification of Sensors (based on measurement, working principle, etc.) - Overview of Sensor Characteristics (sensitivity, accuracy, precision, etc.) - Basic sensor types and principle - Sensor Signal Conditioning - Amplification and Filtering - Analogto- Digital Conversion (ADC) - Digital Signal Processing (DSP) for Sensors - Calibration and Compensation Techniques - Sensor Interfaces and Communication - Analog andDigital Interfaces - Wireless Sensor Networks (WSN) - Communication Protocols (I2C, SPI, UART, etc.). |           |             |       |
| UNIT-III                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |             | 9 Hrs |
| <b>Implementation and Deployment Challenges in Industrial IoT:</b> Interoperability and Compatibility-Security Concerns-Cybersecurity RisksData Privacy-Scalability and Complexity-System Scalability- Complexity ManagementLegacy Systems Integration-Compatibility with Existing Infrastructure- Reliability and Maintenance-Data Management and Analytics-Data Overload-Real- time Processing.                                                                                                                                                                                                                                                                    |           |             |       |
| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |             | 9 Hrs |
| <b>Internet of Things Applications:</b> Smart Metering, e-Health Body Area Networks, CityAutomation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector.<br><br><b>Industry-Specific Applications:</b> Manufacturing (Smart factories, predictive maintenance)-                                                                                                                                                                                                                                                                                                                             |           |             |       |

Energy (Smart grids, asset monitoring)-Healthcare (Remote patient monitoring, medical device management)- Agriculture (Precision farming, livestock tracking- Transportation (Fleet management, logistics optimization).

**TextBook(s):**

1. Industrial Internet of Things: Cybermanufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017.
2. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018

**Reference Book(s):**

1. Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress), 2017
2. Internet of Things: Architecture and Design Principles, by Raj Kamal, McGraw Hill Education (India) Private Limited.

| Course Articulation Matrix (CAM): |             |     |     | U24EC802F : <b>INDUSTRIAL</b> IoT |      |      |     |     |     |     |      |      |      |      |
|-----------------------------------|-------------|-----|-----|-----------------------------------|------|------|-----|-----|-----|-----|------|------|------|------|
|                                   | CO          | PO1 | PO2 | PO3                               | PO4  | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC802F.1 | 3   | 2   | 1                                 | 1    | 2    | 1   | -   | -   | -   | -    | -    | 2    | 2    |
| CO2                               | U24EC802F.2 | 2   | 2   | 3                                 | 2    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO3                               | U24EC802F.3 | 2   | 2   | 3                                 | 3    | 3    | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| CO4                               | U24EC802F.4 | 1   | 2   | 2                                 | 3    | 3    | 3   | -   | -   | -   | -    | 2    | 2    | 2    |
| U24EC802F                         |             | 2   | 2   | 2.25                              | 2.25 | 2.75 | 2   | -   | -   | -   | -    | 2    | 2    | 2    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |             |     |     |                                   |      |      |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                      |                      |                                                 |                                                                                                         |
|-------------------------|------------------------------------------------------------------------------------------------------|----------------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                              | Relevant<br>SDG      | SDG<br>Description                              | Mapping Justification                                                                                   |
| CO1                     | Explain the fundamentals of industrial IoT, their components, and technologies.                      | SDG4                 | Quality Education                               | Provides foundational knowledge in embedded systems.                                                    |
| CO2                     | Explain sensor and their functionality and their use in industrial IoT.                              | SDG9                 | Industry, Innovation, Infrastructure            | Hardware-software co-design supports resilient digital infrastructure.                                  |
| CO3                     | Demonstrate the implementation and deployment challenges in Industrial IoT.                          | SDG8                 | Decent Work & Economic Growth                   | RTOS skills enhance employability in embedded and IoT industries.                                       |
| CO4                     | Analyse the applications of Internet of things in industries and learn to deploy a task accordingly. | SDG3, SDG 11, SDG 13 | Good Health, Sustainable Cities, Climate Action | Advanced embedded technologies enable healthcare devices, smart cities, and energy-efficient solutions. |

| RADAR AND SATELLITE COMMUNICATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |             |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------|--------------|
| Class: B. Tech. VIII- Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          | Branch: ECE |              |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | U24EC803 | Credits:    | 3            |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2-1-0-3  | CIE:        | 60%          |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 36Hrs    | ESE:        | 40%          |
| <b>Course Learning Outcomes (COs)</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |             |              |
| <b>CO1 :</b> classify the radar system describe the principle of operation of MTI, Doppler radars                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |             |              |
| <b>CO2 :</b> select the radar for target tracking, identify pulse compression techniques and understand phased array radar architecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |             |              |
| <b>CO3 :</b> understand the orbital and functional principles of satellite communication systems, interpret and select appropriate technologies for implementation of specified satellite communication systems.                                                                                                                                                                                                                                                                                                                                                                                           |          |             |              |
| <b>CO4 :</b> analyse and evaluate a satellite link and suggest enhancements to improve the link performance. Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.                                                                                                                                                                                                                                                                                                                                                                  |          |             |              |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |             | <b>9 Hrs</b> |
| <b>Introduction to Radar:</b> Different types of radar systems, radar block diagram, radar equation, detection of signals in noise, receiver noise and SNR, transmitter power, pulse repetition frequency (PRF), beam shapes.<br><b>MTI and Pulse Doppler Radar:</b> Introduction to MTI and doppler radar, delay line cancellers, staggered PRFs, digital MTI processing, moving target indicator, limitation to MTI performance, pulse doppler radar.<br><b>Radar Clutter:</b> Introduction, surface clutter radar equation, land clutter, sea clutter, weather clutter, detection of targets in clutter |          |             |              |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |             | <b>9 Hrs</b> |
| <b>Tracking Radar:</b> Tracking with radar, mono-pulse tracking, conical scan and sequential lobing, limitation to tracking accuracy, tracking in range, low angle tracking<br><b>Information from Radar Signals:</b> Basic radar measurements, theoretical accuracy of radar measurements, Ambiguity diagram, Pulse compression techniques, target recognition;<br><b>Phased Array Radar Architectures:</b> Introduction, antenna-based architectures, bandwidth-based architectures, function-based radars, scalable radar architectures.                                                                |          |             |              |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |             | <b>9 Hrs</b> |
| <b>Satellite Orbits and Trajectories:</b> Definition, basic principles, orbital parameters, injection velocity and satellite trajectory, types of satellite orbits, orbital perturbations, satellite stabilization, orbital effects on satellite's performance, eclipses, look angles: azimuth angle, elevation angle.<br><b>Satellite Subsystem:</b> Power supply subsystem, attitude and orbit control, tracking, telemetry and command subsystem, payload<br><b>Earth Station:</b> Types of earth station, architecture, design considerations, satellite tracking                                      |          |             |              |

| UNIT-IV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 9 Hrs |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <p><b>Multiple Access Techniques:</b> Introduction, FDMA, SCPC systems, MCPC systems, TDMA, CDMA, SDMA</p> <p><b>Satellite Link Design Fundamentals:</b> Transmission equation, satellite link parameters, propagation considerations</p> <p><b>Communication Satellites:</b> Introduction, related applications, frequency bands, payloads, satellite vs. terrestrial networks, satellite telephony, satellite television, satellite radio, regional satellite systems, national satellite systems</p>                                                            |       |
| <p><b>TextBook(s):</b></p> <ol style="list-style-type: none"> <li>1. Sklonik Merrill, Introduction to Radar Systems, 3rd ed., New Delhi: Tata McGraw-Hill, 2001.</li> <li>2. Tom Jeffrey, Phased-Array Radar Design: Application of Radar Fundamentals, SciTech Publishing, Inc. 2009, ISBN 978-1-891121-69-2.</li> <li>3. Anil K. Maini, Varsha Agrawal, Satellite Communications, New Delhi: Wiley India Pvt. Ltd., 2015.</li> </ol>                                                                                                                             |       |
| <p><b>Reference Book(s):</b></p> <ol style="list-style-type: none"> <li>1. Nagaraja N. S., Elements of Electronics Navigation, 2nd ed., New Delhi: Tata McGraw-Hill, 1996.</li> <li>2. Sharma K. K., Radar, Sonar and Navigation Engineering, 2nd ed., New Delhi: S K Kataria &amp; Sons, 2006.</li> <li>3. Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd ed., New Delhi: Wiley India Pvt. Ltd., 2017.</li> <li>4. Dennis Roddy, Satellite Communications, 4th ed., New Delhi: McGraw-Hill International edition, 2006.</li> </ol> |       |
| <p><b>Web and Video link(s):</b></p> <p><a href="https://nptel.ac.in/courses/117105131">https://nptel.ac.in/courses/117105131</a>; NPTEL Video Satellite Communication, by Prof. Kalyan Kumar Bandyopadhyay, Professor of Electronics and Electrical Communication Engineering department, IIT Kharagpur</p>                                                                                                                                                                                                                                                       |       |

| Course Articulation Matrix (CAM): |            |     |     | U24EC803 :RADAR AND SATELLITE COMMUNICATIONS |     |     |     |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|-----|----------------------------------------------|-----|-----|-----|-----|-----|-----|------|------|------|------|
|                                   | CO         | PO1 | PO2 | PO3                                          | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC803.1 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| CO2                               | U24EC803.2 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| CO3                               | U24EC803.3 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| CO4                               | U24EC803.4 | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| U24EC803                          |            | 2   | 2   | 1                                            | 2   | -   | -   | 1   | 1   | 1   | 1    | -    | 2    | 1    |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |     |                                              |     |     |     |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                                                                         |                 |                                                                                                                                                                             |                                                                                                                                                                                                                                                               |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement<br><i>The student should be able to...</i>                                                                                                                                                                                                 | Relevant<br>SDG | SDG<br>Description                                                                                                                                                          | Mapping Justification                                                                                                                                                                                                                                         |
| CO1                     | classify the radar system<br>describe the principle of<br>operation of MTI, Doppler<br>radars                                                                                                                                                           | SDG 9           | <b>Industry,<br/>Innovation and<br/>Infrastructure</b> –<br>Build resilient<br>infrastructure,<br>promote<br>sustainable<br>industrialization,<br>and foster<br>innovation. | Radar technologies are fundamental<br>to modern transportation,<br>surveillance, weather monitoring, and<br>defense infrastructure. Understanding<br>radar principles supports<br>technological innovation and<br>development of advanced sensing<br>systems. |
| CO2                     | select the radar for target<br>tracking, identify pulse<br>compression techniques<br>and understand phased<br>array radar architecture                                                                                                                  | SDG 9           | <b>Industry,<br/>Innovation and<br/>Infrastructure</b> –<br>Develop reliable,<br>sustainable, and<br>resilient<br>infrastructure<br>through<br>technological<br>innovation. | Advanced radar architectures such as<br>phased-array systems improve<br>detection accuracy, tracking<br>capability, and operational efficiency,<br>contributing to innovative<br>infrastructure and intelligent<br>monitoring systems.                        |
| CO3                     | understand the orbital<br>and functional principles<br>of satellite communication<br>systems, interpret and<br>select appropriate<br>technologies for<br>implementation of<br>specified satellite<br>communication systems.                             | SDG 9           | <b>Industry,<br/>Innovation and<br/>Infrastructure</b> –<br>Increase access<br>to information<br>and<br>communication<br>technologies and<br>foster<br>innovation.          | Satellite communication enables<br>global connectivity, remote<br>communication services, disaster<br>management, and digital inclusion,<br>thereby strengthening communication<br>infrastructure worldwide.                                                  |
| CO4                     | analyse and evaluate a<br>satellite link and suggest<br>enhancements to improve<br>the link performance.<br>Select an appropriate<br>modulation, multiplexing,<br>coding and multiple<br>access schemes for a given<br>satellite communication<br>link. | SDG 11          | <b>Sustainable<br/>Cities and<br/>Communities</b> –<br>Make cities and<br>human<br>settlements<br>inclusive, safe,<br>resilient, and<br>sustainable.                        | Efficient satellite communication<br>systems support smart-city services,<br>emergency communication networks,<br>disaster response, remote sensing, and<br>sustainable urban and rural<br>connectivity.                                                      |

| MAJOR PROJECT PHASE-II                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |             |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------|-----|
| Class: B. Tech. VIII – Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           | Branch: ECE |     |
| Course Code:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | U24EC804  | Credits:    | 6   |
| Hours/Week (L-T-P-E):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0-0-12-12 | CIE:        | 60% |
| Total Number of Teaching Hours:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | -         | ESE:        | 40% |
| <b>Course Learning Outcomes (COs):</b><br><i>After completion of this course, the students should be able to,</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |             |     |
| <p>Upon completion of the major project work, students will be able to...</p> <p>CO1: review research literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real-world complex engineering problems (Technical skills)</p> <p>CO2: design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a real-world problem guided by ethical, environmental, societal and sustainable development considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget (Problem solving and critical thinking skills)</p> <p>CO3: apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader to produce time-sensitive deliverables in a multi-disciplinary team (Ethics and teamwork)</p> <p>CO4: collate the results, compare performance of prototype to design specifications and present clearly and effectively the proposed solution, conclusions and/or recommendations in written (report, poster, technical paper), oral (presentations) and multimedia formats (video pitch) and engage in self-directed independent learning and life-long learning demonstrating the KSQ of a professional engineer (Communication skills and life-long learning)</p>                                                                                                                                                                                                                                                                                                                                                                                                            |           |             |     |
| <ol style="list-style-type: none"> <li><b>Major project work shall be continued in 8<sup>th</sup> semester as major project phase-II:</b> All the major project teams shall take the <i>phase -I</i> work forward and complete the remaining work as <i>Phase-II</i> in the 8<sup>th</sup> semester.</li> <li>Final Year Major Project work represents the culmination of study towards the B. Tech degree. <b>Major project offers an opportunity to integrate the knowledge acquired from various courses and apply it to solve real-world complex engineering problems.</b> The <b>student learning assessment process</b> (SLAP) shall include good number of presentations, demonstration of work undertaken, submission of a project report, writing project paper in scientific journal style &amp; format, preparing project poster and creating video pitch on the complete project</li> <li>Activities of major project SLAP shall be planned in such a way to ensure that the students acquire the essential knowledge, skills and qualities (KSQ) of a professional engineer.</li> <li><b>Team work:</b> Major project work is a team work <ol style="list-style-type: none"> <li>The students of a project team shall work together to achieve a common objective.</li> <li>Every student of a project team is expected to function effectively as an individual, and also with others as a team member in an ecosystem of team having knowledge diversity, gender diversity, social and cultural diversity among its members.</li> </ol> </li> <li>Every student is expected to put approximately <b>168 hours of work</b> into the major project phase-II course over the 12 weeks of 8<sup>th</sup> semester.</li> <li><b>Major project work Phase-II: 8<sup>th</sup> semester</b> <ol style="list-style-type: none"> <li>The convener DPEC shall release complete schedule of <i>phase-II</i> CIE during last week of 7<sup>th</sup> semester (<i>well in advance before start of 8<sup>th</sup> semester</i>), immediately after</li> </ol> </li> </ol> |           |             |     |

completion of Progress Presentation-I, so that student teams would complete the scheduled works during inter-semester break and get ready with informative, confident and comfortable presentation for progress presentation-II.

- (ii) The project supervisors: The project supervisors are expected to guide the students to systematically continue the phase-I work, useful work during inter- semester break, meeting the deadlines as proposed in project timeline.
- (iii) The project supervisors shall ensure students focus on the project objectives and expected deliverables
- (iv) The project supervisors shall ensure students have sufficient resources for successful project completion.
- (v) The project supervisors shall ensure students have sufficient resources for successful project completion.
- (vi) The project supervisors shall continue guiding students on
  - (a) *Knowledge, skills and qualities (KSQ) of a professional engineer to be acquired* to propose solutions and design the systems to the identified real-world problems.
  - (b) *Problem analysis* -to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
  - (c) *Applying engineering knowledge* - to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
  - (d) *Design/development of solutions* - to design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental Considerations
  - (e) *Conduct investigations of complex problems* - to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
  - (f) *Modern tool usage* – to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
  - (g) *The Engineering and the world*– to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
  - (h) *Ethics* – to apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice
  - (i) *Individual and team work* – to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
  - (j) *Communication* – to communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
  - (k) *Project management and finance* – to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

- (l) *Life-long learning* – to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
- (vii) The project supervisors are also expected to continuously emphasize and guide the students on
  - (a) **Following project timeline:** completing the tasks as planned in project timeline
  - (b) **Meeting Cadence:**
    - i. **Regular meetings with supervisor:** Short and frequent meetings increase a team's work momentum. Regular meetings with supervisor to review the status of project are very essential. All students of the team shall participate in discussions and take notes.
    - ii. **Meeting Frequency: Semi-weekly cadence,** i.e., the meeting frequency shall be **twice a week**. Due weightage will be given to meeting cadence and considered for evaluation during presentations, i.e., number of planned meetings and number attended by students
  - (c) **Project Log Book:** The activity journaling in project log book is very important for a successful project.
    - i. Project log book is a written record showing the daily project activity on project goals from the very first thing like starting the project (an introduction statement what the project is all about), to the completion of the work (including the final results, and whether project met the core objectives / outcomes, etc.).
    - ii. In project log book, the activities like regular meetings with project supervisor, and work carried out on daily/weekly basis are to be recorded. This ensures that the student progress is being monitored well.
    - iii. The project supervisor shall regularly check the log book of every student of project team and endorse each and every activity by affixing his signature with date. With this, the number of planned meetings and number attended by the students will be also monitored.
    - iv. Log books are to be shown during all presentations and will be graded along with the project.
    - v. At the conclusion of the project work *phase-II*, the supervisor shall specifically comment, in the project log book, on whether the project team met each of the project work outcomes and to give evidence which describes the quality of work. For project teams, this also serves as self-assessment.
  - (d) **Writing down whatever is done and making notes of whatever is read.** Writing down the procedures / models followed, designs made, experiments conducted, simulations carried out, intermediate results obtained, **difficulties faced and how they were fixed** are very important. This kind of documenting the whole process as we go with project implementation is a very effective way and will help preparing a well- documented report having original content. Note down and include information about all the resources that you used, magazines, Journals, patents, books, and so on. This information will be needed for the bibliography in your project report. On the other hand, documenting a report **on the spur of the moment** would end up copying things from other sources resulting in a plagiarized document.
  - (e) The relevant knowledge, skills and qualities (**KSQ**) an engineering graduate should possess, which can be specially acquired by participating in major project work

- (f) **Good and sufficient literature review:** Literature review is a description and analysis of information related to the topic of project work. Reading good number of review articles, research articles published in recent issues of peer reviewed journals, technical magazines, patents, reference books on the topics of potential interest, will help one understand what has already been discovered and what questions remain to identify gaps in the literature.
- (g) Completing the proposed work by the end of *phase-II*
- (h) Right conduct of research to promote academic integrity, honesty and time management
- (i) Preparing a well-documented overall project report in proper format, covering the complete work carried out during both the phases (*phase-I and phase-II*).
- (j) Consequences of plagiarism, and use of anti-plagiarism software to detect plagiarism in the report
- (k) Submission of major project work report within acceptable plagiarism levels (including AI Plagiarism), as per the ***Anti-plagiarism policy-2020 of our institute***
- (l) **Video pitch on complete project work:** Capturing short videos, photos, screenshots on experiments conducted, simulations carried out, prototype / working model / process / software package / system developed during course of project execution, photos showing interaction with supervisor for creating a short video pitch on the complete work done during both phases (*phase-I and phase-II*).
- (m) **Project Paper:** Writing a technical paper at the end of *phase-II* based on the solution(s) proposed, results obtained and prototype / working model / process / software package / system developed, for submission to a reputed non-predatory conference/non-paid peer reviewed journal.
- (n) **Project poster:** At the end of *phase-II*, the project teams shall have to present their project in the form of posters, at the time of demonstration of complete prototype / working model / software package / system developed.
- (viii) **Phase – II evaluation:** There shall be only Continuous Internal Evaluation (CIE) for major project work *phase-I* with following components
  - (a) **Progress Presentation -II (during third / fourth week of 8<sup>th</sup> semester):** The progress presentation-II shall include the identified problem, objective(s), literature review, expected outcome(s), results of work done as per project plan timeline.
    - i. **Following project timeline:** The project timeline shall be meticulously followed and the tasks shall be completed as planned in project timeline.
    - ii. 80-85% of work is expected to be completed
    - iii. Project teams shall compulsorily show the following as part of their progress presentation-II
      - 1. *The slides on project timeline and*
      - 2. *A table showing targeted tasks as per timeline and status – whether tasks accomplished?*
    - iv. **Project log book:** Every student of the Project team shall compulsorily show the activity journaling in the log book (with due signatures of project supervisor) during presentations
  - (b) **Final Presentation (during penultimate week of 8<sup>th</sup> semester):** **Project supervisor shall ensure that the project team has accomplished 100% of work proposed.** The project team shall

- i. **Follow project timeline:** The project timeline shall be meticulously followed and the tasks shall be completed as planned in project timeline.
- ii. compulsorily show the following as part of their final presentation
  1. *The slides on project timeline and*
  2. *A table showing targeted tasks as per timeline and whether all the identified tasks accomplished?*
- iii. **show project log book:** Every student of the Project team shall compulsorily show the complete activity journaling in the log book (*with due signatures of project supervisor*)
- iv. present complete results & analysis
- v. **demonstrate the completed project:** working model/process/software package/system developed
- vi. demonstrate the completed project with the **project poster presentation**

(ix) **Evaluation for Major project phase-II:** There shall be continuous internal evaluation (CIE) and end semester examination (ESE). The evaluation for *phase-II* shall be as given below:

| Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Weightage   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>A. CIE</b><br>(i) <b>Supervisor Assessment(10%)</b><br>(ii) <b>DPEC Assessment(50%)</b><br>(a) <i>Progress presentation-II(10%)</i><br>(b) <i>Final presentation(10%)</i><br>(c) <i>Working model/process/software package/system developed(20%)</i><br>(d) <i>Project video pitch(5%)</i><br>(e) <i>Project paper(5%)</i>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>60%</b>  |
| <b>B. ESE</b><br>(i) <i>Well-documented project report(15%)</i><br>(DPEC shall evaluate the project reports, as per the rubrics, well before the ESE. At the time of ESE, the evaluated project report marks shall be posted in the award list, along with the ESE oral presentation marks. Students shall appear for Viva-Voce with a project report)<br>(ii) <i>Oral presentation with PPTs and viva-voce(10%)</i><br>(iii) <i>Project poster(5%)</i><br>(DPEC shall evaluate the project poster, as per the rubrics, well before the ESE. At the time of ESE, the evaluated project poster marks shall be posted in the award list. Students shall appear for Viva-Voce with a project poster)<br>(iv) <i>SDG (5%)</i><br>(v) <i>Research Orientation (5%)</i> | <b>40%</b>  |
| <b>Total Weightage</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>100%</b> |

- (a) **Working Model:** Every project team shall be required to develop a working model/ process/software package/system on the chosen work. The completed working model/ process/software package/system shall be demonstrated during the final presentation at the end of *phase-II*.
- (b) **Video pitch:** Every project team shall be required to create a pitch video, which is a video presentation on their major project work *phase-I & phase-II*. The project team shall present the produced video pitch during Final presentation. The produced video pitch should
  - (i) be 3 to 5-minute-long video (no longer than 5 minutes)
  - (ii) be concise and to the point, on the problem, proposed solution and its

- salient features.
- (iii) show project timeline and sample page of log book
  - (iv) highlight the various stages during project implementation with the help of short videos / photos / screenshots on experiments conducted, simulations carried out, prototype / working model / process / software package / system developed as part of proposed solution and also photos showing team interactions with supervisor and the team working in the lab on project.
  - (v) discuss the impact of proposed solution in *ethical, environmental, societal and sustainable development contexts*.
  - (vi) emphasize key points about *business idea, potential market for the proposed solution*
- (c) **Project poster:** At the end, the project teams shall present their project in the form of posters (A2 size). The teams shall have to present their work during the poster presentation session scheduled at the end of the 8<sup>th</sup> semester, at the time of demonstration of complete porotype / working model / software package / system developed.
- (d) **Well-documented plagiarism-cleared project report:** Every project team shall be required to submit a well-documented project report on the work carried out, as per the format specified by the DPEC. The report should clear plagiarism check as per the anti-plagiarism policy-2020 of the institute. The following shall compulsorily be included in the Results-Chapter of the project report
- (i) Photos / screen shots taken at various stages during the development of working model/ process/software package/system as part of Results-Chapter
  - (ii) Snapshot of final working model/ process/software package/system developed
  - (iii) Pictures of the team working in the lab, the team discussing with the project supervisor, working on creative project, or an event they are attending for work.
  - (iv) *All these photos / screen shots shall be properly referred in the project report by assigning figure numbers*
- (e) **Tangible outcomes of project work in Conclusions - Chapter:** These are the lessons learnt from doing a project work. The students have to describe in their own words what they learnt from the project work experience. They have to describe what specific KSQs are acquired by them, with reference to the expected COs, after successful completion of major project work. Finally, a table depicting systematic mapping of what they have learnt and the expected major project work COs, is to be shown in the conclusions chapter.
- (f) **Student feedback on major project in Conclusions - Chapter:** To gather information on whether project work was useful and gave practical experience on chosen field of interest, and other learning, a well-defined feedback questionnaire (*made available by the dept*) with closed and open questions shall be kept in the conclusions chapter of the project report.
- (x) It is mandatory for
- (a) every student of the team to appear for ESE oral presentation and viva-voce, to qualify for course evaluation
  - (b) every project team to write a technical paper based on the solution(s) proposed, results obtained and prototype/working model/process/software package/system developed, for submission to a reputed non-predatory conference/non-paid peer-reviewed journal
  - (c) every project team shall be required to create a pitch video, which is a video presentation on their major project work phase-I & phase-II

- (d) every project team shall present their project in the form of a poster, during the demonstration of complete prototype/working model/software package/system developed
- (xi) The student has to register for the Major project work phase-II as supplementary examination in the following cases:
  - (a) he/she is absent for oral presentation and viva-voce as part of ESE presentation
  - (b) he/she fails to fulfill the requirements of Major project work phase-II evaluation as per specified guidelines
- (xii) Supplementary examination for Major project work phase-II
  - (a) The CoE shall send the list of students registered for supplementary examination to the HoDs concerned
  - (b) The DPEC, duly constituted by the HoD, shall conduct Major Project Phase-II supplementary exam and send the award list to the CoE within the stipulated time

| Course Articulation Matrix (CAM): |            |     |      | U24EC804: MAJOR PROJECT PHASE II |     |      |      |     |     |     |      |      |      |      |
|-----------------------------------|------------|-----|------|----------------------------------|-----|------|------|-----|-----|-----|------|------|------|------|
| CO                                |            | PO1 | PO2  | PO3                              | PO4 | PO5  | PO6  | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                               | U24EC804.1 | 3   | 3    | 2                                | 3   | 2    | 1    | 1   | 1   | 1   | 1    | 2    | 2    | 2    |
| CO2                               | U24EC804.2 | 3   | 2    | 3                                | 2   | 2    | 1    | 2   | 1   | 1   | 2    | 2    | 2    | 1    |
| CO3                               | U24EC804.3 | 1   | 1    | 1                                | 1   | 1    | 2    | 1   | 1   | 2   | 2    | 1    | 2    | 1    |
| CO4                               | U24EC804.4 | 1   | 1    | 1                                | 2   | 2    | 1    | 2   | 1   | 2   | 1    | 2    | 2    | 2    |
| U24EC804                          |            | 2   | 1.75 | 1.75                             | 2   | 1.75 | 1.25 | 1.5 | 1   | 1.5 | 1.5  | 1.75 | 2    | 1.5  |
| 3 - HIGH, 2 - MEDIUM, 1 - LOW     |            |     |      |                                  |     |      |      |     |     |     |      |      |      |      |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                                                                                                                                                                       |              |                                         |                                                                                                                                                              |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                                                                                                                                                                                                                                                                                       | Relevant SDG | SDG Description                         | Mapping Justification                                                                                                                                        |
| CO1                     | review research literature, identify gaps in the literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real-world complex engineering problems (Technical skills) | SDG 13       | Industry, Innovation and Infrastructure | Research-based innovation and development of advanced ECE solutions contribute to technological progress, industrial growth, and infrastructure development. |
| CO2                     | design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a                                                                                                                                                                         | SDG 12       | Responsible Consumption and Production  | Sustainable design practices, efficient resource utilization, and environmentally responsible engineering                                                    |

| CO-SDG Alignment Matrix |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |                                    |                                                                                                                                    |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| CO                      | CO Statement (The student should be able to...)                                                                                                                                                                                                                                                                                                                                                                                                             | Relevant SDG | SDG Description                    | Mapping Justification                                                                                                              |
|                         | real-world problem guided by ethical, environmental, societal and sustainable development considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget (Problem solving and critical thinking skills)                                                                                                                                                                             |              |                                    | solutions promote responsible production and innovation.                                                                           |
| CO3                     | Apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader of a multidisciplinary team.                                                                                                                                                                                                                                        | SDG 11       | Sustainable Cities and Communities | Collaborative development of engineering solutions addressing societal needs contributes to sustainable and resilient communities. |
| CO4                     | Collate the results, compare performance of prototype to design specifications and present clearly and effectively the proposed solution, conclusions and/or recommendations in written (report, poster, technical paper), oral (presentations) and multimedia formats (video pitch) and engage in self-directed independent learning and life-long learning demonstrating the KSQ of a professional engineer (Communication skills and life-long learning) | SDG 4        | Quality Education                  | Technical communication, knowledge dissemination, and self-directed learning support continuous education and professional growth. |