DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

B. TECH.CURRICULUM

ACADEMICYEAR:2025–26

DEPARTMENTOFELECTRONICS & COMMUNICATION ENGINEERING

Revised Undergraduate Rules and Regulations-2024 (URR24-R25)
In accordance with the National Education Policy 2020
w.e.f. A.Y. 2025-26

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

Estd-1980
KITSW

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

(UGC Autonomous Institute Under Kakatiya University, Warangal)

1st Semester Syllabus

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 (Universal Human Values - I)						-
1	BSC	U24MH101	Differential Calculus and Ordinary Differential Equations	2	1	-	6	9	3
2	BSC	U24PY102E	Engineering Physics *(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 *(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 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

Class: B.Tech. I -Semester		**Branch:** Common to all branches	
Course Code:	**U24MH101**	**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%**

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

UNIT-I	**9 Hrs**

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 valuetheorem(Geometricalinterpretation),Cauchy'smeanvaluetheorem,Taylor'stheorem(Generalizedmean valuetheorem),Expansionsoffunctions- Maclaurin'sseries, 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)]*

UNIT-II	**9 Hrs**

Partial differentiation and its applications: Functions of two or more variables,Partial derivatives, Total derivative, Change ofvariables,Jacobians,Functionalrelationship,Geometricalinterpretation-Tangentplane and Normal to a surface, Taylor's theorem for function of two variables (without proof), Errors and approximations, Total differential, Maximaandminimaoffunctionsoftwovariables,Lagrange'smethodofundeterminedmultipliers,Differentiationundertheintegralsign

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
Differentialequations offirstorder (DE): Reorientationofdifferentialequationof firstorder and firstdegree(Formation a differentialequation, variables separable method, homogeneous equations,Linear equations),Exactdifferentialequations,Equationsreducibletoexactequations **Applicationsofdifferentialequationsoffirstorder:**Orthogonal trajectories - Orthogonal trajectories of the family of curves f (x, y, c) =0, 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 Radio-active materials, Rate of growth of population ***Self-Learning Topics (SLTs):*** *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)].*	
UNIT-IV	**9 Hrs**
Linear differential equations: Lineardifferentialequationswithconstantcoefficients, Rules for finding complementary function, Inverse operator, Rules for finding the particular integral(Q=e^{ax}, sin(ax+b) or cos(ax+b), $x^m$and e^{ax}V(x)), Methodofvariationofparameters, Linear dependence of solutions **Applicationsoflineardifferentialequations**:Simple harmonic motion, Simple pendulum, Oscillations of spring, Oscillatory electrical circuit-LCR circuit, Electro-mechanical analogy ***Self-Learning Topics (SLTs):****Finding the particular integral of Q(X) =X^mV(X) [(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)].*	
Course Learning Outcomes (COs): *After completion of this course, the students should be able to…* **CO1**:examine the convergence of a series and interpret mean value theorems **CO2**: apply partial differentiation to functions of several variables in solving various engineering problems **CO3**: apply appropriate methods of differential equations of first order and first degree to solve real life engineering problems **CO4**: analyze the solutions of higher order linear differential equation with constant coefficients	
Textbook(s): 1. Grewal, B.S., *Higher Engineering Mathematics*, 44thed.Khanna Publishers, Delhi, 2017	
Reference Book(s): 1. Shanti Narayan, Dr. Mittal P.K, *Differential Calculus*, S. Chand & Co., New Delhi, 1sted. Reprint 2014 2. Kreyszig E, *Advanced Engineering Mathematics*, 10thed. Inc, U.K, John wiely & sons, 2020 3. S.S. Sastry, *Engineering Mathematics, Vol.II,* Prentice Hall of India, 3rded., 2014	
Web and Video link(s):	

1. https://youtu.be/4EYko9rdF7g?si=WUu12*NPTEL Video Lecture on Infinite seriesby Prof. S.K.Ray, Professor of Mathematics, IITK Kanpur.*
2. https://youtu.be/0apMXhWG_W8?si=M-abw2Gq3buX5HLM*NPTEL Video Lecture on Fundamental mean value theorems by Prof. Jithedra Kumar, Professor of Mathematics, IITK Kharagpur.*
3. https://youtu.be/6r5jfT8xrXM?si=ryLXYVJr4-iUkdlV; *NPTEL Video Lecture on Exact Differential Equations, Prof. Jithedra Kumar, Professor of Mathematics, IIT Kharagpur.*
4. https://youtu.be/kbGhrqV9AOM?si=yGyK_V7kJKGa3OaR*NPTEL Video Lecture on Orthogonal Trajectories of family of curves by Prof. Aditya Sharma, Professor of Physics, IISE Bhopal.*
5. *https://youtu.be/btOCUmJkrrg?si=zq3nB00kplm7b5se; NPTEL Video Lecture on Higher Order Linear Differential Equations, Prof. Jithedra 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 fibers

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

Applied Optics and Lasers: 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

Fiber Optics: 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)

Self Learning Topics (SLTs):*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

Dielectric materials: Introduction, Permittivity, Dielectric constant, Polarization, Dielectric polarization mechanisms- Electronic, Ionic, Orientational and Space charge polarization (qualitative); Dielectric breakdown

Magnetic and Superconducting materials: 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

Self-Learning Topics (SLTs):*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

Semiconductor Physics: 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

Semiconductor Diode Characteristics: 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 ***Self-Learning Topics (SLTs):****solved problems (Text2: example 1.5, 1.6, 1.13, 2.2, 2.7, 2.13).*	
UNIT-IV	**9 Hrs**
Bipolar Junction Transistors: 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 **Special Diodes:** 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 ***Self-Learning Topics (SLTs):****solved problems (Text2: 4.11, 4.12, 4.20, 4.21)*	
LABORATORY COMPONENT	
List of Experiments 1. Linear Measurements using Vernier callipers and screw gauge 2. Determination of slit width using He-Ne laser 3. Determination of wavelength of He-Ne laser-using reflection and transmission diffraction grating 4. Numerical aperture and acceptance angle of an optical fiber 5. Determination of dielectric constant of materials using parallel plate capacitor 6. Magnetic hysteresis- B-H curve tracing using CRO 7. Study of V-I characteristics of PN junction diode 8. Study of V-I characteristics of Zener diode 9. Study of common emitter characteristics of NPN transistor 10. Study of common base characteristics of NPN transistor 11. Energy band gap of a semiconductor material 12. Determination of Hall coefficient, carrier density of given semiconducting material using Hall effect setup	
Textbook(s): 1. M. Avadhanulu and Kshirsagar, TVS Arun Murthy, *A Text Book of Engineering Physics*, S. Chand & Company Ltd, 11thed. ISBN- 978-93-528-3399-3, 2018 2. S Salivahanan, N Suresh Kumar, *Electronic devices and circuits,* Mc Graw Hill Education (India) private limited, ISBN-10: 93-392-1225-8, 2015 3. K.B.Raina, S.K.Bhattacharya, T. Joneja, *Electrical Engineering Materials and Electronic Components*, S.K.Kataria & Sons Publisher, ISBN-10: 81-85749-84-1, 2005	
Reference Book(s): 1. Bhattacharya and Bhaskaran, *Engineering Physics*, Oxford University Press, 1sted. ISBN-9780198065425, 2013 2. V. Rajendran, *Engineering Physics*, Mc Graw Hill, ISBN-13: 978-9-35-134295-3, 2013 3. R.K. Gaur and S.L.Gupta, *Engineering Physics*, Dhanpath Rai and Sons publications, ISBN-10: 8189928228, 2013	

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

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc24_ph28/preview; *NPTELvideo lecture onConcepts in Magnetism and Superconductivity by Prof. Arghya Taraphder IIT Kharagpur*
2. https://onlinecourses.nptel.ac.in/noc24_lw07/preview; *NPTEL video lecture on Introduction to Law on Electricity by Prof. Uday Shankar, IIT Kharagpur*
3. https://onlinecourses.nptel.ac.in/noc24_ph45/preview; *NPTEL Video Lecture on Introduction to LASER - Course by Prof. M. R. Shenoy, IIT Delhi*
4. 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):

1. *Engineering Physics Laboratory Manual & Record Book,* Department of PS, KITSW
2. 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 inCB,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%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: number system and binary codes, minimization of switching functions
LO2: combinational circuits design and implementation using logic gates, adders/subtractors, multiplexer and decoders
LO3: implementation of sequential circuits, counters, registers using flip flops and logic gates
LO4: finite state machines and its minimization

UNIT-I	9 Hrs

Number Systems: 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
Boolean Algebra: Postulates and theorems, logic gates and truth tables, representation of switching functions using SOP & POS forms, Karnaugh map representation, minimization using K-Map

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).*

UNIT-II	9 Hrs

Combinational Circuits: 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

Self-Learning Topics (SLTs): *decimal adder (Text1: topic 4.6),Priority encoders (Text2: topic 4.22)*

UNIT-III	9 Hrs

Sequential Circuits: 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)

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)*

UNIT-IV	9 Hrs

State minimization: state table, state diagram, state assignment, state minimization, synthesis of synchronous, sequential circuits – sequence detectors
Finite State Machines: Mealy and Moore machines – capabilities and limitations of finite state machine, state equivalence and machine minimization- Merger graph and Merger table

Self-Learning Topics (SLTs):*capabilities and limitations of finite state machine (Ref Text3:10.2) simplification of incompletely specified machines (Ref Text3:10.4)*

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, 1st edition, 2012
2. R.P. Jain, *Modern Digital Electronics*, Tata McGraw-Hill, India, 4th edition, 2010
3. Zvi. Kohavi, *Switching and Finite Automata Theory*, Cambridge University Press, 3rd edition, 2010
4. Samuel. C. Lee & B.S. Sonde, *Digital Circuits & Logic Design*, PHI, New delhi, 1st 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=BPBiyzc0OBw*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.*

CourseArticulationMatrix(CAM)						**U24EC103 SWITCHINGTHEORYANDLOGICDESIGN**								
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	**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,

Function calls, Function declaration, Category of functions, Recursion, The scope, visibility and lifetime of variables (storage classes)

Self-Learning Topics (SLTs): *Arithmetic operations on characters, comparison of strings (Text1: chapter 9), Nesting of functions, (Text1: chapter 10), Solved problems (Text1: chapter 9 & chapter 10), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 9 & chapter 10)*

UNIT-IV	9 Hrs

Structures and Unions: Defining a structure, Declaring and initializing structure variables, Accessing structure members, Array of structures, Structures within structures, Unions

Pointers: Understandingpointers, Declaring and initializing pointer variables, Pointer expressions, Pointers and arrays, Pointers and character strings, Pointers to functions, Pointers and structures

File Management in C: Defining and opening afile, Closing a file, Input and output operations on sequential text files

Self-Learning Topics (SLTs):*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).*

LABORATORY COMPONENT

List of Experiments

1. Programs using input output functions, operators (arithmetic, relational and conditional)
2. Programs using operators (bit-wise, logical, increment and decrement)
3. Programs using conditional control structures: if, if-else, nested if
4. Programs using else if ladder, switch and goto statements
5. Programs using loop control structures: while
6. Programs using loop control structures: do-while and for
7. Programs on one dimensional array and two-dimensional arrays
8. Programs on String operations and string handling functions
9. Programs on different types of functions, parameter passing using call-by-value & call-by-address, recursion and storage classes
10. Programs using structures, unions, pointers to arrays and pointers to strings
11. Programs using array of pointers and pointers to structures
12. Programs on File operations and file handling functions for sequential text files

Textbook(s):

1. E. Balagurusamy, *Programming in ANSI C*,8th ed.McGraw Hill, 2022

Reference Book(s):

1. Paul Deitel, Harvey Deitel, *C How to Program: With Case Studies Introducing Applications Programming and Systems Programming*, Pearson Education Limited, 9th ed. 2022
2. Brian W. Kernighan and Dennis Ritchie, *The C Programming Language*, Pearson Education India, 2nd ed. 2015
3. Reema Thareja, *Programming in C,* Oxford University Press, 3rd ed. 2023

4. Yashavant Kanetkar, *Let Us C,* BPB Publications, 19thed. 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 & π 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 π 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 HillEdition, 2010.
4. Chakravarthy A, Sudhipanath and Chandan Kumar, Basic *Electrical Engineering*, Tata McGraw Hill Ltd, 4thed. 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:**CommontoCE, EEE, ECIE, ECE & CSE	
CourseCode:	**U24CY106**	**Credits:**	**0**
Hours/Week(L-T-P-O-E):	**2-0-0-3-5**	**CIE:**	**60%**
TotalNumberofTeachingHours:	**24Hrs.**	**ESE:**	**40%**

CourseLearningObjectives(LOs):

Thiscourse willdevelopstudents' knowledgein/on…

LO1:natural resources and their usage more equitably

LO2: ecosystem and the importance of biodiversity conservation

LO3: environmental pollution and it'scontrol measures

LO4: environmental legislation and green methodology

UNIT-I	6Hrs

The Multidisciplinary Nature of Environmental Studies: Definition, Scope and importance

Natural Resources: 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

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)*

UNIT-II	6Hrs

Ecosystem and Biodiversity:

Ecosystem: Concepts of an ecosystem, Food chain, Food webs, Ecological pyramids, Energy flow in the ecosystem and ecological succession

Biodiversity and its Conservation: 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

Self-Learning Topics (SLTs): *Introduction and definition of biodiversity (Text1: unit 4, topic 4.1)*

UNIT-III	6Hrs

Environmental Pollution: Global Issues**-**Global climatic change, Greenhouse gases, Effects of global warming, Ozone layer depletion

International Conventions/Protocols: Earth summit, Kyoto protocol, Montreal protocol **Environmental Pollution-**Causes and effects of air, Water, Soil, Marine and noise pollution with case studies

Solid and Hazardous Waste Management: Introduction, Types, Effects of urban industrial and nuclear waste

Natural Disaster Management: Introduction to disaster, Management of disaster, Disaster management of flood, earthquake, cyclone and landslides

Role of information technology in environment and human health

Self-Learning Topics (SLTs): *Role of individual in prevention of pollution (Text1: unit 5, topic 5.10)*

UNIT-IV	6Hrs

Social Issues and the Environment: Role of Individual and Society, Water conservation, Rain water harvesting

Environmental Protection/Control Acts: 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

Green Methodology: Principles of green chemistry, green methods in electronic production, Impact of electronic waste on public health and environment;United nations goals of sustainable development

Self-LearningTopics(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)*

CourseLearningOutcomes(COs):

Aftercompletionofthiscourse,thestudentsshouldbeableto,

CO1: identifythe naturalresources and practice their usage more equitably

CO2:developanactionplanforsustainablealternativesandconserving biodiversity

CO3:examine and perceive the solutions for the environmental pollution

CO4:adapt issues involved in enforcement of environmental legislation and green methodology

Textbook(s):

1. ErachBharucha,*TextBook of EnvironmentalStudies for UnderGraduateCourses,*2nded.UniversitiesPress(India)Pvt.Ltd,2013

ReferenceBook(s):

1. Y. Anjaneyulu, *Introduction to Environmental Science*, B.S. Publications, 2004
2. Gilbert M. Masters, *Introduction to Environmental Engineering & Science*, 3rded. Prentice Hall of India,1991
3. Anubha Kaushik, C.P. Kaushik, *Environmental Studies*, 4th Edition, New Age International Publishers,2014
4. R. Rajagopalan, *Environmental Studies from crisis to cure*, Oxford University Press, 2nded. 2011

Weband Videolink(s):

1. 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*

CourseArticulationMatrix(CAM):		**U24CY106ENVIRONMENTAL 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

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

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

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_2 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		• Students are required to create an affordable prototype as their course project, based on the knowledge and skills acquired during the course. • Students have to present and submit their prototypes to demonstrate their ability to apply classroom learning practically, showcasing their creativity and technical aptitude.

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

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

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: preparingwell-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**	**U24PY102E**	**U24EC103**	**U24EC104**	**U24EE105B**	**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.	oll number of the student	Practicum topic allotted	Practicumunder the course	urse 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)

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(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
Total	100 marks

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 teacheras 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. Isemester	**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:**	**-**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: holistic development through activity-based learning to gain real-life experiencewhicheffectively help individualsdeal appropriately with problems/challenges

LO2: positive mindsetby 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-documentedreport and an effective oral presentationthrough 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** (SelfAccomplishment 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 enrollin the forthcoming semesters.

Monitoring SEA/SAA:

(a) **Nodal units:**The Student Activity Centre (SAC) and Centre for Innovation Incubation Research and Entrepreneurship (C-i^{2}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 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.

(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 helpstudents 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: E**minent 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 studentshall, identifiesminimum of4 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
Total	**100**	**-**

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 XYY(SE/SA) ZZZ**

X represents semester; YYrepresents 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: 1 *SEA/SAA course serial number: 09* *SEA/SAA category: SEA* *course number: 302* The **course code** will be U24VA109SE302	*Semester: 4* *SEA/SAA course serial number: 10* *SEA/SAA category: SAA* *course number: 206* The **course code** will be U24VA410SA206

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:**	**-**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: 21st century skills needed for industry, current industry trends, challenges and innovations
LO2: latest technology in practice andapplying knowledge to solve real-world problems

LO3: smart work, soft skills, professional etiquette, networking abilities

LO4: making a well-documented reportportraying the knowledge, skills, qualities acquired and the impact of the learning

In the 21st 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 21st 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^{2}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^{2}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^{2}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 (*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
Total	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.

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

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 21st 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***

2nd Semester Syllabus

II SEMESTER

S. No.	Category	Course Code	Course Title	Lectures / week					Credits
				L	T	P	O	E	C
1	BSC	U24MH201	Matrix Theory and Vector Calculus	2	1	-	6	9	3
2	BSC	U24CY202E	Engineering Chemistry *(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 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%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: various methods of solving system of linear equations and eigen value problems
LO2: double integral, triple integral and their applications
LO3: vector differential calculus and applications
LO4: integration of vector valued functions and applications

UNIT-I	**9 Hrs**

Matrices:
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)
Applications of Eigen value problems: Stretching of an elastic membrane, Eigen value problems arising from Markov processes, Eigen value problems arising from population models, Leslie model

Self-Learning Topics (SLTs): *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**

Multiple Integrals and Beta, Gamma functions:
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)

Self-Learning Topics (SLTs): *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**

Vector Calculus and its applications: - 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_yOK1vtk?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**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PSO**	**PSO**

		1	2	3	4	5	6	7	8	9	10	11	1	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 and thermoplasticresins, 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)	
UNIT-IV	**9 Hrs**

Engineering Materials

Nanomaterials: 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

Nanoscale materials: Fullerenes, Carbon nanotubes, 2D nanomaterials-graphene, Properties and applications; Biosensors

Self-Learning Topics (SLTs): *Introduction to nanotechnology* **(***Text1:chapter 37 topic 1)*

LABORATORY COMPONENT

List of Experiments

1. Estimation of hydroxide ion [OH^-] by acidimetry using standard sodium carbonate solution
2. Estimation of alkalinity of water sample containing (i) carbonate; (ii) carbonate & bi carbonate in ground water
3. Estimation of alkalinity of water sample containing (i) bicarbonate; (ii) carbonate & hydroxide in potable water
4. Determination of hardness of water by complexometric method
5. Determination of dissolved oxygen in a sample of water
6. Standardization of sodium hydroxide (NaOH) by conductometry using standard hydrochloric acid (HCl)
7. Standardization of acetic acid (CH_3COOH) by conductometry using standard sodium hydroxide (NaOH)
8. Standardization of strong acid hydrochloric acid (HCl) by potentiometry using standard sodium hydroxide (NaOH)
9. Colorimetric analysis-verification of Lambert-Beer's law
10. Estimation of ferrous (Fe^{2+}) ion in the given solution using potassium permanganate
11. Preparation of nanoparticles of cadmium sulphide (CdS)
12. Synthesis of polymer (phenol- formaldehyde)

Textbook(s):

1. Jain and Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Company,17th ed. 2019

Reference Book(S):

1. J.C.Kuriacose and J.Rajaram, *Chemistry in Engineering and Technology*(vol.I & vol.II), Tata Mc. Graw-Hills Education Pvt. Ltd., 2010
2. Shashi Chawla, *Text book of Engineering Chemistry*, Dhanpat Rai Publishers,3rded. 2003
3. S.S. Dara, S. S. Umare, *A Text book of Engineering Chemistry*, S.Chand & Company Ltd., 12th ed. 2010

Web and Video link(s):

1. *https://elearn.nptel.ac.in/shop/iit-workshops/completed/battery-cell-technology-materials-and-industrial-applications/?v=c86ee0d9d7ed NPTEL Video Lecture on Battery technology by Dr. Kothandaraman, Professor of Chemistry, IIT Madras & Dr. Raghunathan, Professor of Chemical engineering, IIT Madras*

<u>Laboratory Manual</u> (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

<u>(based on psychomotor skills acquired from laboratory component)</u>

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):				**U24CY202EENGINEERING 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):

This course will develop students' knowledge in /on…

LO1: half wave, full wave rectifiers and non-linear wave shaping
LO2: transistor biasing and thermal stabilization
LO3: FET characteristics, its operation, biasing
LO4: Small signal low frequency transistor amplifier circuits

UNIT-I	9 Hrs

Review of conduction in semiconductors and PN Junction Diode

Rectifiers: Half Wave Rectifier, Full wave Rectifier, Harmonic Components in Rectifier Circuits, Inductor Filter, Capacitor Filter, L - Section Filter, and π - Section Filter

Non-Linear Wave Shaping Circuits: 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

Self-Learning Topics (SLTs): *solved problems (Text1: Prob 2.10, 2.14, 2.16, 2.19, 2.30), Clipping circuits (Text2: topic 7.2)*

UNIT-II	9 Hrs

Review of BJT characteristics in CB, CE and CC configurations

Transistor Biasing & Thermal Stabilization: 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 β for the Self Bias Circuit (S'&S''), Bias Compensation using diode, thermal runaway, thermal Stability

Self-Learning Topics (SLTs): *Solved problems (Text1: Prob 4.12, 4.14, 4.15), Solved problems (Text1: Prob 4.30, 4.31)*

UNIT-III	9 Hrs

Field Effect Transistors: 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

FET Biasing: Fixed Bias Configuration, Self-Bias Configuration, Common Gate Configuration, Common Drain Configuration

Self-Learning Topics (SLTs):*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

Small Signal Low Frequency Transistor Amplifier Circuits: 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. Salivahanan and N Suresh Kumar., *Electronic Devices and Circuits*, 2nded.Mc GrawHill, 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.Anand kumar, *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; *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

Data Structures: Basic terminology, Classification of data structures, Applications and operations on data structures, Time and space complexity
Arrays: 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,
Dynamic Memory Allocation: Memory allocation functions, Dynamic memory allocation for single- and two-dimensional arrays

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)*

UNIT-II	9 Hrs

Stacks: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)
Queues:queues, Array representation of queues, Double ended queues, Circular queues

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)*

UNIT-III	9 Hrs

Linked Lists: 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

Self-Learning Topics (SLTs): *Merging (Text1: topics 3.3), Skip list (weblink: https://www.geeksforgeeks.org/skip-list/), 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)*

UNIT-IV	9 Hrs

Sorting Techniques: Selection sort, Insertion Sort, Shell sort and radix sort, Time complexities of sorting
Hashing: 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, 2nded. 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														

ENGLISHCOMMUNICATIONANDREPORTWRITING

Class: B.Tech. II –Semester		**Branch:**Commontoallbranches	
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%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: basicgrammarprinciples,readingspeed,formingnewwords,makingcoherentparagraphsandalso promoting ethical values for meaningful life

LO2: speakingorwritingcorrectsentences,writingeffectivelettersandimprovingthem self-worth

LO3: criticalreadingability,writingconclusivereportsandadditionallyinculcating positivethinking

LO4: abridgingvarietiesoflengthytextsandmaintainingemotionalbalance

UNIT-I	**9 Hrs**

GRAMMAR

- Tenses-Structures-usage-examples-exercisesforpractice
- SentenceCorrection-Correct use of Tenses, Verb forms, Punctuation.

VOCABULARY

- Wordformation:Prefixes-Suffixes-SentenceFormationwithnewlyformedwords

READINGSKILL

- Definition-SubskillsofReading-EmphasisonSkimming-Purpose-Howtoskimthroughthetext-Examples, Exercises for practice

WRITINGPRACTICES

- ParagraphWriting-Definition-OrganizingPrinciplesofparagraphs-Makingaparagraphthrough hints/graphs and pictures-Coherence-Linking Devices-Systematic Development of Ideas
- Paraphrasing-Précisinglengthyexpressionsforclarityandbrevity

LIFE SKILLS: Ethical Values and Humanity

TheLastLeaf:AShortStorybyO.Henry

Self-LearningTopics(SLTs):

Articles-(Text2, Unit-II),EnglishVocabulary(Text2, Unit-I,Unit-II,Unit-III)
VerbForms(Referencebook1, Topic:31),Tenses(Referencebook1, Topics:16,17,18,19)
Reported Speech (Reference book 2, Exercises for Practice, Topics: 161-167)

UNIT-II	**9 Hrs**

GRAMMAR

- Tenses-Revision-Exercisesforpractice
- Subject-VerbAgreement
- ReportedSpeech-Transformation
- SentenceCorrection-EmphasisConcord, Report Speech, Sentence Structures

VOCABULARY

- Synonyms-Antonyms-SingleWordSubstitutes-PopularAbbreviations

READINGSTRATEGY

- EmphasisonScanningtheText-Purpose-Advantages-Examples,ExercisesandPracticethroughTeamwork

WRITINGPRACTICES

- LetterWriting-EffectiveLetterWritingTechniques-InformationSeekingLetters-Job
- ApplicationLetters- Apology Letters-Explanation to Memos- E-mails-Cover Letters-Resume

LIFESKILLS:Determination

- HowIBecameaPublicSpeaker:AnessaybyGeorgeBernardShaw

Self-LearningTopics(SLTs):*EnglishVocabulary(Text2, Unit-I, Unit-II, Unit-III), Tenses(Referencebook3, Topic-30, Exercises,30.1,30.2,30.3)*

UNIT-III	9 Hrs

GRAMMAR

- Tenses-Revision-ExercisesforPractice
- Nouns-Prepositions-Adverbs-Adjectives
- SentenceCorrection:CorrectUseoftenses,nouns,prepositions,adverbsandadjectives

VOCABULARY

- PhrasalVerbs-TechnicalWords-LatinWords

READINGSTRATEGY

- IntensiveReading-purpose-TypesofComprehensionQuestions-Examples,ExercisesandPracticethrough Teamwork

WRITINGPRACTICES

- ReportWriting-Definition-Purpose-QualitiesofaGoodReport-FormalandInformalReports-Report Format-Sample Reports-Exercises
- EmphasisonTechnicalReports

LIFESKILLS:PositiveAttitude

- BetheBestofWhateverYouAre:APoembyDouglasMalloch

Self-LearningTopics(SLTs):*PartsofSpeech(Textbook1, Unit-I), Tenses(Referencebook1,Topics-16,17,18,19) Phrasal Verbs (Reference book 3)*

UNIT-IV	9 Hrs

GRAMMAR

- Tenses-Revision-ExercisesforPractice
- Clauses-Conjunctions-TransformationofSentences
- SentenceCorrection(BasedonPartsofSpeech)-Clauses-Tenses

VOCABULARY

- AppropriateUseofWordsinCommunication-CommonlyConfusedWords

ACTIVEREADINGandNOTE-MAKING

- Note-Making-Definition-Purpose-Effectiveness

WRITINGPRACTICES

- PrécisWriting-Definition-Purpose-Uses-ExamplesandExercises-PracticethroughTeamwork

- PreparingStatementofPurpose(SoP)

LIFESKILLS: EmotionalBalanceAPoisonTree:PoembyWilliamBlake

Self-LearningTopics(SLTs):Tenses(Referencebook2, Topics:152-157)

CourseLearningOutcomes(COs):

Aftercompletionofthiscourse,thestudentsshouldbeableto…

CO1: applybasic grammarprinciples inspeech andwriting, readfast,formnewwords,makecoherentparagraphs and adapt the real value of life

CO2: createeffectiveletters,e-mails,replytoMemosanddothegiventaskswithconfidence

CO3: analyzethegiventextsandwriteclearandunambiguousreports

CO4: deduct the superfluous information from lengthy text, prepare SoP(Statement of Purpose) effectively andsolve critical problems in life with emotional balance

Textbook(s):

1. SanjayKumar&PushpLata,*EnglishLanguageandCommunicationSkillsforEngineers,* 1sted.AsperthelatestAICTEsyllabus,OxfordUniversityPress, 2018.
2. *LanguageandLife: ASkill'sApproach,*2nd ed.BasedonthelatestAICTEmodelcurriculumOrientBlackswan Private Limited 2019.

ReferenceBook(s):

1. Thomson A.J.,Martinet A.V.,*APracticalEnglishGrammar*,3rded.OxfordUniversityPress,1997
2. Thomson A.J., Martinet A.V,*APracticalEnglishGrammar*,3rd ed.Exercise2,OxfordUniversity Press,1997
3. StandardAllen W.,*LivingEnglishStructure*,5thed.PearsonIndiaEducationPvtLtd. 2009

Web and Video link(s):

1. **https://onlinecourses.nptel.ac.in/noc20_hs56/preview**Technical English for Engineers by Aisha Icbal, IIT madras.
2. https://onlinecourses.swayam2.ac.in/cec21_lg13/previewIndianWritinginEnglishbyDr.Bindu AnnPhilip,StMary's CollegeTrissur

CourseArticulationMatrix(CAM):		**U24MH205ENGLISHCOMMUNICATION&REPORTWRITING**												
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

Class: B. Tech.II-Semester	**Branch:** Common to all branches

Course Code:	U24VA206	Credits:	1
Hours/Week(L-T-P-O-E):	0-0-2-2-4	CIE:	60%
Total Number of Teaching Hours:	24Hrs	ESE:	40%

Course Learning Objectives (LOs):

Thiscoursewilldevelopstudents'knowledgein/on…

LO1: Yoga and its benefits

LO2: various sports & games

LO3: sportsman spirit

LO4: all round development

Sports and Games

List of Sports and Games

1. Badminton
2. Basket Ball
3. Chess
4. Carrom
5. Foot Ball
6. Table Tennis
7. Volley Ball
8. Cricket
9. Hand Ball
10. Kabaddi
11. Kho-Kho
12. Yoga Aasanas

Textbook(s):

1. B.K.Chaturvedi, *Rules and Skills of Games and Sports,* Publisher – Goodwill Publishing House, B-9, Rattan Jyoti, 18 Rajendra Place, New Delhi.

ReferenceBook(s):

1. Dr. Sakure Girish Madhaorao, *Foundation of Physical Education and Sports*, Sports Publication,New Delhi.

Web and Video link(s):

1. Badminton game Video Link: https://www.youtube.com/watch?v=HucIqi8Lw3E&t=22s
2. Basket Ball game Video Link: https://www.youtube.com/watch?v=-tkE2lJoR58
3. Chess Video Link: https://www.youtube.com/watch?v=mDw7lgM8ePo
4. Carrom game Video Link: https://www.youtube.com/watch?v=z8vvJpNceeg
5. Football game Video Link: https://www.youtube.com/watch?v=mXjW78AgGu4
6. Table Tennis game Video Link: https://www.youtube.com/watch?v=bLrJGWvWI4U
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
9. Handball game Video Link:
   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
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 aasanas

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

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

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

<u>Web and Video link(s):</u>

1. *https://onlinecourses.nptel.ac.in/noc20_me79/preview NPTEL video link for Engineering **drawing and computer graphics** By Prof. Rajaram Lakkaraju, IIT Kharagpur.*

<u>Laboratory Manual</u> (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

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

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: preparingwell-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, shallprepare 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	U24CY202E	U24EC203	U24EC204	U24MH205	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: ……….

S.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)

****

(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
Total	100 marks

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

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: **holistic development** through activity-based learning to gain real-life experiencewhicheffectively help individualsdeal 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** (SelfAccomplishment 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 enrollin the forthcoming semesters.

Monitoring SEA/SAA:

(a) **Nodal units:**The Student Activity Centre (SAC) and Centre for Innovation Incubation Research and Entrepreneurship (C-i^{2}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 helpstudents 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: E**minent 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 studentshall, identifiesminimum of4 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
Total	**100**	**-**

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 XYY(SE/SA) ZZZ**

X represents semester; YYrepresents 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: 1 *SEA/SAA course serial number: 09* *SEA/SAA category: SEA* *course number: 302* The **course code** will be U24VA109SE302	*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

Class: B. Tech.II -Semester	**Branch:** Common to all branches		
Course Code:	**U24AE211**	**Credits:**	**1**
Hours/Week (L-T-P-O-E):	**0-0-0-1-1**	**CIE:**	**100%**
Total Number of Teaching Hours:	**-**	**ESE:**	**-**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: 21st century skills needed for industry, current industry trends, challenges and innovations

LO2: latest technology in practice andapplying knowledge to solve real-world problems

LO3:smart work, soft skills, professional etiquette, networking abilities

LO4:making a well-documented reportportraying the knowledge, skills, qualities acquired and the impact of the learning

In the 21st 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 21st 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^{2}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^{2}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^{2}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 (*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
Total	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.

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

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 21st 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***

1st 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).
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, *Power Electronics*, 2nded.McGraw Hill education, New Delhi, 2007
2. Thomas. E. Kissell, *Industrial Electronics*,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,5thed.2012
3. P.C. Sen, *Power Electronics*, Tata McGraw Hill, New Delhi,24th reprint, 2005

Laboratory Manual (for laboratory component):

1. *IndustrialElectronics 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):					**U24EC212XINDUSTRIAL 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

Textbook(s):

1. A.K.Sawhney, *Electrical, Electronic measurement & Instrumentation*, Dhanpat Rai & sons, 18thed. 2012

Reference Book(S):

1. David A. Bell,*Electronic Instrumentation and Measurements*, Oxford Univ. Press, 1997
2. A.D. Helbincs, W.D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, PHI,5th ed.2003
3. K. Lal Kishore, *Electronic Measurements and Instrumentation*, Pearson Education,2010

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc24_ee117/preview; *NPTEL Video Lecture on Electrical Measurement and Electronic instruments by By Prof. Avishek Chatterjee | IIT Kharagpur*

Laboratory Manual (for laboratory component):

1. *Electronic Measuring Instruments 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 the performance characteristics of a measuring system

CO2: identify the various electronic instruments based on their specifications for carrying out a particular task of measurement

CO3: design bridge circuits for the measurement of unknown R, L and C

CO4: measure various physical parameters by appropriately selecting the transducer

(based on psychomotor skills acquired from laboratory component)

CO5: demonstrate the use of PMMC meter for conversion of ammeter to voltmeter & for A.C. voltage measurement and determine resistance & frequency using Wheatstone & Wien's bridge circuits

CO6: interpret the operation of CRO for measurement of frequency & phase using Lissajous patterns and examine Strain gauge transducer for strain measurement

CO7: utilize LVDT & capacitive transducers to measure displacement and examine RTD &thermocouple transducers for temperature measurement

CO8: examine Hall transducer for pressure

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, 1st 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,6th edition, 2016

Web and Video link(s):

1. 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)

)5: design and test the functionality of rectifiers
)6: design a LED circuit Zener regulator.
)7: implement Boolean functions using logic gates.
)8: design combinational circuitsand 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
CO6	**U24EC214X.6**	2	2	2	1	2	1		-	2	1	2	1	1	1
CO7	**U24EC214X.7**	2	2	2	1	2	1		-	2	1	2	1	1	1
CO8	**U24EC214X.8**	2	2	2	1	2	1		1	2	1	2	1	1	1
	U24EC214X	**2.5**	**2.25**	**2.66**	**1**	**2**	**1**		**1**	**2**	**1**	**2**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 – LOW															

3rd Semester Syllabus

III SEMESTER

S. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	BSC	U24MH301H	Applied Mathematics (for ECE)	2	1	-	3	3
2	PCC	U24EC302	Electronic Circuits Analysis and Design	2	1	-	3	3
3	PCC	U24EC303	Digital Design	2	1	-	3	3
4	PCC	U24EC304	Signals and Systems	3	1	-	4	4
5	ESC	U24EC305	OOP through Java#	2	1	-	3	3
6	PCC	U24EC306	Electronic Circuits Analysis and Design Laboratory	-	-	2	2	1
7	SEC	U24SE307	Programming Skill Development Lab – 2 (C & DS)	-	-	2	2	1
8	PCC	U24EC308	Digital Design Laboratory	-	-	2	2	1
9	ESC	U24EC309	OOP through Java Laboratory	-	-	2	2	1
			Total:	11	5	8	24	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)				-	-	-	-	-

*** Branch Specific Mathematics:**

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

APPLIED MATHEMATICS (*for ECE*)

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24MH301H**	**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 : apply Laplace transforms to solve differential equations

CO2 : represent a given function in Taylor's and Laurent's series and evaluate integrals using integral theorems.

CO3 : evaluate various statistical parameters of a random variable

CO4 : perform various operations on multiple random variables.

UNIT,I	**9 Hrs**

Laplace Transforms: 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 ‗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.

Operational Calculus: Transfer functions, Solution of ordinary differential equations with constant coefficients and system of ordinary differential equations with constant coefficientsusing 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

Z-Transforms: Some standard z-transforms, Damping rule, Some standard results, Multiplication by 'n', Inverse z-transforms, Convolution theorem, Convergence of z-transforms.

UNIT-II	**9 Hrs**

Complex Integration: 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.

UNIT-III	9 Hrs
Random Variable: 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. **Operations on One Random Variable– Expectation:** 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.	
UNIT-IV	**9 Hrs**
Multiple Random Variables: 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. **Operations on Multiple Random Variables**: Expected value of a function of Random Variables, Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions; Jointly Gaussian Random Variables. **Random Processes:** Random Process Concept – Classification, Distribution and density functions, Concept of stationarity and statistical independence, Poisson random process.	

Textbook(s):

1. Grewal, B.S., *Higher Engineering Mathematics*, Khanna Publishers, Delhi, 44th ed. 2017 (Chapters 20, 21, 23).
2. Peyton Z. Peebles, *Probability,Random Variables and Random Signal Principles*, 4th ed.*TMH*, 2001 (Chapters 2,3,4,5,6)

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 Digita*l, 2nded. *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*, 3rded. *Prentice Hall*, 2002
6. Athanasios Papoulis and S. Unnikrishnan Pillai, *Probability, Random Variables and Stochastic Processes*, 4th 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		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**U24EC301H.1**	2	1	1	-	-	-	1	1	-	1	2	-	1
CO2	**U24EC301H.2**	2	1	1	-	-	-	1	1	-	1	2	-	1
CO3	**U24EC301H.3**	2	1	1	-	-	-	1	1	-	1	2	-	1
CO4	**U24EC301H.4**	2	1	1	-	-	-	1	1	-	1	2	-	1
U24EC301H		**2**	**2**	**1**	**-**	**-**	**-**	**1**	**1**	-	**1**	**2**	-	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 Laplace transforms to solve differential equations	SDG 4	Quality Education	Mathematical tools support engineering problem solving and lifelong learning.
CO2	represent a given function in Taylor's and Laurent's series and evaluate integrals using integral theorems.	SDG 4	Quality Education	Complex analysis develops analytical and critical thinking skills.
CO3	evaluate various statistical parameters of a random variable	SDG 9	Industry, Innovation & Infrastructure	Probability and statistics are essential for communication and engineering systems.
CO4	perform various operations on multiple random variables.	SDG 9	Industry, Innovation & Infrastructure	Random processes are used in modern signal processing and communication technologies.

ELECTRONIC CIRCUITS ANALYSIS AND DESIGN

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24EC302**	**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 : analyse the given circuit by drawing relevant h-parameter, hybrid-π 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

UNIT-I	9 Hrs

High Frequency Transistor Amplifier Circuits: Review of BJT biasing, operating point, small signal analysis of BJT,The Hybrid- π (pi) common emitter transistor model, Hybrid-π conductances, CE short circuit current gain, High frequency model of a transistor α and β 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

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^{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

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

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

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):

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.*

Course Articulation Matrix (CAM):				U24EC302:ELECTRONIC CIRCUITS ANALYSIS AND DESIGN										
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
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
U24EC302		2	2.5	2.75	1	1	1.25	1	1	1	-	2	3	2
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	analyse the given circuit by drawing relevant h-parameter, hybrid-π equivalents and design single stage BJT amplifier for given specification	SDG 9	Industry, Innovation & Infrastructure	Amplifier design contributes to electronic system development.
CO2	analyse the frequency response of multistage transistor amplifiers and FET amplifiers at low frequencies.	SDG 9	Industry, Innovation & Infrastructure	Efficient amplifier analysis improves communication infrastructure.
CO3	design the negative feedback amplifiers and oscillator circuits.	SDG 9	Industry, Innovation & Infrastructure	Oscillators and feedback circuits are key building blocks of modern electronics.
CO4	evaluate the efficiencies of large signal amplifiers and calculate the Q-factor various tuned amplifiers	SDG 7	Affordable & Clean Energy	Efficient power amplifiers help reduce energy consumption.

DIGITAL DESIGN

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24EC303**	**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 : 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.

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	

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	

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	

UNIT-IV	9 Hrs
Dataflow Modeling: Continuous assignments, Delay specification, Expressions, Operators, Operands and operator types **BehavioralModeling:** 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	

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.Cilletti, "*Digital Design*", PHI, India, 4th ed. 2006
Web and Video link(s):
https://onlinecourses.nptel.ac.in/noc24_cs61/preview*NPTEL Video Lecture onDigital Design with Verilog by Prof. Chandan Karfa and Prof. Aryabartta Sahu, IIT Guwahati.*

Course Articulation Matrix (CAM):		**U24EC303: DIGITAL DESIGN**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
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
U24EC303		3	2.75	2.25	1.25	1.75	1	1	1	1	-	-	2	2.25
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	justify the selection of a logic family for a given application based on Figure of Merit	SDG 9	Industry, Innovation & Infrastructure	Logic family selection improves digital system performance.
CO2	build a memory system using ROM/RAM hierarchy and propose PLD-based solutions for given constraints	SDG 9	Industry, Innovation & Infrastructure	Memory and PLD design support digital innovation.
CO3	examine the functional violations using gate-level modeling in Verilog HDL	SDG 4	Quality Education	Verilog modeling develops modern digital design skills.
CO4	design the Verilog module using generate blocks and automate testbenches for functional verification.	SDG 9	Industry, Innovation & Infrastructure	Digital system design enables advanced technological solutions.

SIGNALS AND SYSTEMS

Class: B. Tech. III – Semester		**Branch:**ECE	
Course Code:	**U24EC304**	**Credits:**	**4**
Hours/Week (L-T-P- E):	**3-1-0-4**	**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: 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

UNIT-I	9 Hrs

Signals and Systems: 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

Linear Time–Invariant (LTI) Systems: DT-LTI systems: Convolution sum, CT-LTI systems: Convolution integral

UNIT-II	9 Hrs

Continuous-Time Fourier Series (CTFS): Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series, Dirichlet's conditions

Continuous-Time Fourier Transform (CTFT): 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)

UNIT-III	9 Hrs

Discrete-Time Fourier Series (DTFS): Fourier series representation of DT periodic signals, Properties of DTFS

Discrete-Time Fourier Transform (DTFT): 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).

UNIT-IV	9 Hrs

z*-Transform: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

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; *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 ;*NPTEL Video Lecture on Properties of Linear Systems*
3. 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;*NPTEL Video Lecture on Z-Transform*

Course Articulation Matrix (CAM):				**U24EC304: SIGNALS AND SYSTEMS**										
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
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														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Classify CT and DT signals and systems, apply signal transformations, and evaluate LTI system responses using convolution	SDG 4	Quality Education	Fundamental signal analysis strengthens engineering knowledge.
CO2	apply the Continuous-Time Fourier Transform (CTFT) for analyzing aperiodic and periodic signals, and analyze systems described by linear constant-coefficient	SDG 9	Industry, Innovation & Infrastructure	Fourier analysis is widely used in communication systems.

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
	differential equations			
CO3	analyze DT signals using Fourier Series and Fourier Transform, apply their properties, and evaluate LCCDE-based systems	SDG 9	Industry, Innovation & Infrastructure	Digital signal processing supports modern technological infrastructure.
CO4	represent LTI systems in Z-domain, including system stability, causality, and realize IIR systems using block diagram	SDG 9	Industry, Innovation & Infrastructure	Z-transform techniques are essential in DSP and embedded applications.

OBJECT ORIENTED PROGRAMMING THROUGH JAVA

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24EC305**	**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: 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

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.

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

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

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.

Textbook(s):

1. HerbertSchildt, *Java TheComplete 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. KathySierra and BertBates, *Head First Java*, 2nd ed. Boston: O'Reilly Media,2005
3. Harvey Deitel and Paul J. Deitel, *Java How to Program,* 11thed. New Delhi: Pearson, 2018

Web and Video link(s):

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

Course Articulation Matrix (CAM):		U24EC305: OBJECT ORIENTED PROGRAMMING THROUGH JAVA												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
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
U24EC305		2	2	2.5	1.67	1.5	-	-	1	-	-	1	1.5	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	analyze the strengths and limitations of various programming paradigms to determine their suitability for solving various programming problems in java	SDG 4	Quality Education	Programming paradigms enhance computational thinking skills.
CO2	develop java programs using classes, constructors, methods and various string concepts	SDG 4	Quality Education	Java programming develops software development competency.
CO3	apply reusability concepts like inheritance, dynamic method dispatch, interfaces and packages to build java programs	SDG 9	Industry, Innovation & Infrastructure	Reusable software components support sustainable software engineering.
CO4	develop java programs using I/O, file handling, exception handling and multithreading concepts	SDG 8	Decent Work & Economic Growth	Industry-relevant programming skills improve employability.

ELECTRONIC CIRCUITS ANALYSIS AND DESIGN LABORATORY

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24EC306**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : analyze the frequency response of single stage and multistage amplifiers

CO2 : design and test the functionality of BJT amplifiers and oscillators

CO3 : design and test single tuned amplifier

CO4 : design and test efficiency and distortions present in power amplifiers

Experiment-1

1. Design and testing of Common Emitter (CE) amplifier

Experiment-2

1. Design and testing of two stage RC coupled amplifier

Experiment-3

1. Design and testing of voltage series feedback amplifier

Experiment-4

1. Design and testing of RC phase shift oscillator.

Experiment-5

1. Design and testing of Hartley oscillator

Experiment-6

1. Design and testing of Colpit's oscillator

Experiment-7

1. Design and testing of single tuned voltage Amplifier

Experiment-8

1. Design and testing of Class A power amplifier (with transformer load)

Experiment-9

1. Design and testing of Class B complementary symmetry amplifier

Experiment-10

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

Experiment-11

1. Design and simulation of voltage series feedback amplifier
2. Design and simulation of RC phase shift oscillator
3. Design and simulation of Hartley and Colpit's oscillators

Experiment-12

1. Design and simulation of single tuned voltage amplifier
2. Design and simulation of Class A power amplifier (transformer less)
3. 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:
ELECTRONIC CIRCUITS ANALYSIS AND DESIGN *Laboratory Manual*, Department of ECE, KITSW.

Course Articulation Matrix (CAM):				**U24EC306:ELECTRONIC CIRCUITS ANALYSIS AND DESIGNLABORATORY**										
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24EC306.1**	3	2	2	1	2	1	1	2	2	1	2	3	2
CO2	**U24EC306.2**	2	3	3	1	2	2	1	2	2	1	2	3	2
CO3	**U24EC306.3**	2	2	3	1	2	2	1	2	2	1	2	3	2
CO4	**U24EC306.4**	2	3	3	1	2	2	1	2	2	1	2	3	2
U24EC306		2.25	2.5	2.75	1	2	1.75	1	2	2	1	2	3	2
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	analyze the frequency response of single stage and multistage amplifiers	SDG 9	Industry, Innovation & Infrastructure	Practical amplifier testing supports electronics innovation.
CO2	design and test the functionality of BJT amplifiers and oscillators	SDG 9	Industry, Innovation & Infrastructure	Hands-on circuit implementation develops engineering skills.
CO3	design and test single tuned amplifier	SDG 9	Industry, Innovation & Infrastructure	Tuned amplifier design is important in communication systems.
CO4	design and test efficiency and distortions present in power amplifiers	SDG 7	Affordable & Clean Energy	Efficiency analysis promotes energy-conscious designs.

PROGRAMMING SKILL DEVELOPMENT LAB – 2

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24SE307**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : Develop C programs using control structures, functions, arrays, strings, and recursion to solve basic computational problems.

CO2 : Apply problem-solving techniques and data structure concepts to design efficient algorithms for numerical and string processing applications.

CO3 : Implement and analyze solutions for real-world problems involving searching, sorting, dynamic programming, and mathematical computations.

CO4 : Develop optimized C programs and evaluate their correctness, efficiency, and applicability to engineering problem-solving.

Experiment-1

(i) Given an integer array, find the number of decreasing sequences in the array and the length of the largest decreasing sequence.

Example:
Input1: {11, 3, 1, 4, 7, 8, 12, 2, 3, 7}

Output1: 2 (No. of decreasing sequences)
Output2: 3 (Largest decreasing sequence)

Input2: {9}

Output1: 0
Output2: 0

(ii) You are given two sorted arrays arr1 and arr2. Merge the two arrays into one **sorted** array.

Constraints:

- Both arr1 and arr2 are sorted in **non-decreasing** order

Examples:
Input:arr1 = [1,2, 4], arr2 = [1,3,4]
Output: [1,1,2,3,4,4]
Example 2:
Input:arr1 = [], arr2 = []
Output: []
Example 3:
Input:arr1 = [], arr2 = [0]
Output: [0]

(iii) Develop a function which takes a number as an input and a string either “even” or “odd” as second argument. The function/method has to written even digits sum if the second argument is “even” or odd digits sum if the second argument is “odd”.

Example:
Input1: argument1: 9625 and argument2: “odd” Output: 9+5 = 14
Input2: argument1: 9625 and argument2: “even” Output: 6+2 = 8

Experiment-2

(i) Write a function to find the count of non-repeated digits in a given number N. The number will be passed to the function as an input parameter of type int.

Example:
If the given number is 292, the function should return 1 because there is only one non-repeated digit ‘9’ present in the number.

(ii) Develop a method “digitSum” which takes an integer as an argument and returns sum of its digits. You have to call this function repeatedly till the integer sum is single digit.

Example:
N = 976592
9+7+6+5+9+2 = 38
3 + 8 = 11
1 + 1 = 2

(iii) Develop a function to return n^{th} number in the Fibonacci series. The value N will be passed to the function/method as input parameter.

NOTE:
Fibonacci series looks like – 0, 1, 1, 2, 3, 5, 8, 13, 21, So on

i.e. Fibonacci series starts with 0 and 1, and continues generating the next number as the sum of the previous two numbers. (Develop both iterative and recursive approaches of the function).

Experiment-3

(i) Assume that the given number input1 can become a palindrome if only one of its digit is removed. i.e. only one digit in the number is out of place. Find the digit that needs to be removed from the input1 to convert input1 to a palindrome.

Example:
If input1 = 12332, the digit ‘1’ needs to be removed to convert input1 to a palindrome 2332. So, the function should return ‘1’. If input1 is palindrome, then return -1.

(ii) Develop a method/function which will compute the sum of the sums of the digits as per below explanation.

Prototype: int sumOfSumsOfDigits(int N);

Example:
If the given number is 582109, the sum of the sums of the digits will be calculated as
= (5+8+2+1+0+9) + (8+2+1+0+9) + (2+1+0+9) + (1+0+9) + (0+9) + 9
= 25 + 20 + 12 + 10 + 9 + 9 = 85

(iii) Given two strings s and t, return true if t is an anagram of s, and false otherwise.

Constraints:

- 1 <= s.length, t.length <= 5 * 10^4
- s and t consist of lowercase English letters.

Examples:
Input: s = "anagram", t = "nagaram"
Output: true
Example 2:
Input: s = "rat", t = "car"
Output: false

Experiment-4

(i) Given a string s, find the **first** non-repeating character in it and return its index. If it **does not** exist, return -1.

Examples:
Input: s = "leetcode"
Output: 0
Explanation:
The character 'l' at index 0 is the first character that does not occur at any other index.

Input: s = "loveleetcode"
Output: 2

Input: s = "aabb"
Output: -1

(ii) Develop a program to do the following.
Input1 = “Warangal”
Input2 = “Telangana”

Input3 = 0/1
Input4 = 0/1

If Input3 == 0 then
Combine non-matching characters from input1 and input2

If input3 == 1 then
Combine matching characters from input1 and input2

If input4 == 0 then
Display the result in lowercase

If input4 == 1 then
Display the result in uppercase

(iii) A phrase is a **palindrome** if, after converting all uppercase letters into lowercase letters and removing all non-alphanumeric characters, it reads the same forward and backward. Alphanumeric characters include letters and numbers.

Given a string s, return true *if it is a* ***palindrome****, or* false *otherwise*.

Example 1:
Input: s = "A man, a plan, a canal: Panama"
Output: true

Explanation: "amanaplanacanalpanama" is a palindrome.

Example 2:
Input: s = "race a car"
Output: false
Explanation: "raceacar" is not a palindrome.

Experiment-5

(i) Given an integer n, return the number of prime numbers that are strictly less than n.

Example 1:
Input: n = 10
Output: 4
Explanation: There are 4 prime numbers less than 10, they are 2, 3, 5, 7.

Example 2:
Input: n = 0
Output: 0

Example 3:
Input: n = 1
Output: 0

(ii) Develop an algorithm to determine if a number n is happy.

A happy number is a number defined by the following process:

- Starting with any positive integer, replace the number by the sum of the squares of its digits.
- Repeat the process until the number equals 1 (where it will stay), or it loops endlessly in a cycle which does not include 1.
- Those numbers for which this process ends in 1 are happy.

Return true if n is a happy number, and false if not.

Example 1:
Input: n = 19
Output: true
Explanation:
$1^2 + 9^2 = 82$
$8^2 + 2^2 = 68$
$6^2 + 8^2 = 100$
$1^2 + 0^2 + 0^2 = 1$

Example 2:
Input: n = 2
Output: false

(iii) Given an array a[] of n integers, find the maximum that maximizes the sum of the values of i*a[i] where I varies from 0 to n-1.

Example:
Input: a[] = {8, 3, 1, 2}
Output: 29

Explanation: Let's look at all rotations
{8, 3, 1, 2} = 8*0 + 3*1 + 1*2 + 2*3 = 11
{3, 1, 2, 8} = 3*0 + 1*1 + 2*2 + 8*3 = 29
{1, 2, 8, 3} = 1*0 + 2*1 + 8*2 + 3*3 = 27
{2, 8, 3, 1} = 2*0 + 8*1 + 3*2 + 1*3 = 17

Experiment-6

(i) Develop a function that takes string as input with all integers separated with colon. The function has to process the colon separated integers and find the minimal integer that is not part of the input and returns the smallest positive value.

Example:
Input: s1 = "1:2:0 "
Output: 3

Input:s1 = "3:4:-1:1"
Output: 2

(ii) In mathematics, a Kaprekar number is a nonnegative integer whose square can be split into two equal parts that add up to the original number again. For instance, 45 is a Kaprekar number, because 45^2 = 2025 and 20+25 = 45. Develop a program to find all Kaprekar numbers within a given range.

(iii) Assume that the user enters the numbers in Base-6 format. Develop a program to add two Base-6 numbers and display the result in Base-6. Ex: input: 24 45, output: 113.

Experiment-7

(i) Write a program to display the leap years that contain the digit '***x***' given by the user, between two given year ***n1*** and ***n2*** both inclusive. For example, if *n1* and *n2* are 1990 and 2020 and if the digit '***x***' is 6, the outputs need to be: The number of leap years between 1990 and 2020 that contains the digit 6 are: 1996, 2016.

(ii) Using the incredible power of the human mind, according to research at Cambridge University, it doesn't matter in what order the letters in a word are, the only important thing is that the first and last letter be in the right place. The rest can be total mess and you can still read it without a problem. This is because the human mind does not read every letter by itself, but the word as a whole. Develop a function *scramble(s)* which scrambles the input string and returns scrambled string. (with first and last fixed).

(iii) Develop a function that takes two numbers in string format and forms a string containing sum (addition) of these two numbers.

Assumptions:
- The input string contains only numeric digits
- The input string can be of any large length
- The lengths of the two input strings need not be the same
- The input strings will represent only positive numbers.

Example:
If input strings are "1234" and "56" the output should be "1290"
If input strings are "123456732128989543219" and "987612673489652", the output should be "123457719741663032871".

Experiment-8

(i) You are given an integer array coins representing coins of different denominations and an integer amount representing a total amount of money.Return the fewest number of coins that you need to make up that amount. If that amount of money cannot be made up by any combination of the coins, return -1.

You may assume that you have an infinite number of each kind of coin.

Example 1:
Input: coins = [1,2,5], amount = 11
Output: 3
Explanation: 11 = 5 + 5 + 1

(ii) Given an integer columnNumber, return its corresponding column title as it appears in an Excel sheet.

For example:
A -> 1
B -> 2
C -> 3
...
Z -> 26
AA -> 27
AB -> 28
...

Example 1:
Input: columnNumber = 1
Output: "A"
Example 2:
Input: columnNumber = 28
Output: "AB"

Example 3:
Input: columnNumber = 701
Output: "ZY"

(iii) Develop a program to find alternate addition and subtraction of input N as per below explanation:

Given number N (1 <= N <= 10000) and an option opt=1 or 2, find the result as per below rules.

If opt = 1 then result = N – (N-1) + (N-2) – (N-3) + (N-4) …. Till 1
If opt = 2 then result = N + (N-1) – (N-2) + (N-3) – (N-4) …. Till 1

Example:
If N = 6, and opt = 1
Result = 6-5+4-3+2-1 = 3

If N = 6, and opt = 2
Result = 6+5-4+3-2+1 = 9

The function prototype should be “int addsub(int N, int opt)”

Experiment-9
(i) Develop a program to find most occurring digit in a given series/list of numbers. Example: Series of input number are: {1237, 262, 666, 140} 0 occurs 1 time 1 occurs 2 times 2 occurs 3 times 3 occurs 1 time 4 occurs 1 time 5 occurs 0 times 6 occurs 4 times 7 occurs 1 time 8 occurs 0 times 9 occurs 0 times 4 is the highest frequency in the series and 6 is the digit that occurs 4 times. (ii) Develop a function/method "long sumOfPowerOfDigits(int N)" to find the sum of powers of each digit of a given number as per the method below. If the number is 582109, then the result can be computed as below. = (5 raised to power of 8) + (8 raised to the power of 2) + (2 raised to the power of 1) + (1 raised to the power of 0) + (0 raised to the power of 9) + (9 raised to the power of 0) = 390625+64+2+1+0+1 = 390693 (iii) Maya has stored few confidential numbers in an array (array of int) to ensure that others do not find the numbers easily. She has applied simple encoding as shown below. Encoding used: Each array element has been encoded with a value that is the sum of its original value and its succeeding element value. i.e. arr[i] = arr[i] + arr[i+1] Note that the value of the last element remains unchanged. Develop a function that takes encoded array and returns the original array. Example: Input: {7, 6, 8, 16, 12, 3} Output: {2, 5, 1, 7, 9, 3}
Experiment-10
(i) The Tribonacci sequence T_n is defined as follows: $T_0 = 0$, $T_1 = 1$, $T_2 = 1$, and $T_{n+3} = T_n + T_{n+1} + T_{n+2}$ for n >= 0. Given n, return the value of T_n. **Examples:** Input: n = 4

Output: 4
Explanation:
T_3 = 0 + 1 + 1 = 2
T_4 = 1 + 1 + 2 = 4

Input: n = 25
Output: 1389537

(ii) Given a string date representing a Gregorian calendar date formatted as DD-MM-YYYY, return *the day number of the year*.

Example 1:
Input: date = "2019-01-09"
Output: 9
Explanation: Given date is the 9th day of the year in 2019.

Example 2:
Input: date = "2019-02-10"
Output: 41

(iii) Given an array of integers nums and an integer target, return indices of the two numbers such that they add up to target.

You may assume that each input would have exactly one solution, and you may not use the same element twice.

You can return the answer in any order.

Constraints:

- 2 <= nums.length <= 10^4
- -10^9<= nums[i] <= 10^9
- -10^9<= target <= 10^9
- Only one valid answer exists.

Example 1:
Input: nums = [2, 7, 11, 15], target = 9
Output: [0,1]
Explanation: Because nums[0] + nums[1] == 9, we return [0, 1].

Example 2:
Input: nums = [3, 2, 4], target = 6
Output: [1, 2]

Example 3:
Input: nums = [3, 3], target = 6
Output: [0, 1]

Experiment-11

(i) You are given two non-empty arrays representing two non-negative integers. The digits are stored in the array, and each of their index value contains a single digit. Add the two numbers and return the sum as another array.

You may assume the two numbers do not contain any leading zero, except the number 0 itself.

Constraints:

The number of elements in each array is in the range [1, 100].
0 <= array_value <= 9
It is guaranteed that the array represents a number that does not have leading zeros.

Examples:

Input: l1 = [2,4,3], l2 = [5,6,4]
Output: [7,0,8]
Explanation: 342 + 465 = 807.

Input: l1 = [0], l2 = [0]
Output: [0]

Input: l1 = [9,9,9,9,9,9,9], l2 = [9,9,9,9]
Output: [8,9,9,9,0,0,0,1]

(ii) Given two sorted arrays nums1 and nums2 of size m and n respectively, return **the median** of the two sorted arrays.
The overall run time complexity should be O(log (m+n)).

Example 1:
Input: nums1 = [1,3], nums2 = [2]
Output: 2.00000
Explanation: merged array = [1,2,3] and median is 2.

Example 2:
Input: nums1 = [1,2], nums2 = [3,4]
Output: 2.50000
Explanation: merged array = [1,2,3,4] and median is (2 + 3) / 2 = 2.5.

(iii) You are given an array prices where prices[i] is the price of a given stock on the i^{th} day.
You want to maximize your profit by choosing a **single day** to buy one stock and choosing a **different day in the future** to sell that stock.
Return *the maximum profit you can achieve from this transaction*. If you cannot achieve any profit, return 0.

Example 1:
Input: prices = [7, 1, 5, 3, 6, 4]
Output: 5
Explanation: Buy on day 2 (price = 1) and sell on day 5 (price = 6), profit = 6-1 = 5.
Note that buying on day 2 and selling on day 1 is not allowed because you must buy before you sell.

Example 2:
Input: prices = [7, 6, 4, 3, 1]
Output: 0
Explanation: In this case, no transactions are done and the max profit = 0.

Experiment-12

(i) You are given a string s of length n containing only four kinds of characters: 'Q', 'W', 'E', and 'R'.

A string is said to be balanced if each of its characters appears n/4 times where n is the length of the string.

Return the minimum length of the substring that can be replaced with any other string of the same length to make s balanced. If s is already balanced, return 0.

Constraints:
1. n == s.length
2. 4 <= n <= 105
3. n is a multiple of 4.
4. s contains only 'Q', 'W', 'E', and 'R'.

Examples:

Input: s = "QWER"
Output: 0
Explanation: s is already balanced.
Example 2:

Input: s = "QQWE"
Output: 1
Explanation: We need to replace a 'Q' to 'R', so that "RQWE" (or "QRWE") is balanced.
Example 3:

Input: s = "QQQW"
Output: 2
Explanation: We can replace the first "QQ" to "ER".

(ii) On an alphabet board, we start at position (0, 0), corresponding to character board[0][0].

Here, board = ["abcde", "fghij", "klmno", "pqrst", "uvwxy", "z"], as shown in the diagram below.

```
a b c d e
f g h i j
k l m n o
p q r s t
u v w x y
z
```

We may make the following moves:

- 'U' moves our position up one row, if the position exists on the board;
- 'D' moves our position down one row, if the position exists on the board;
- 'L' moves our position left one column, if the position exists on the board;
- 'R' moves our position right one column, if the position exists on the board;
- '!' adds the character board[r][c] at our current position (r, c) to the answer.

(Here, the only positions that exist on the board are positions with letters on them.)
Return a sequence of moves that makes our answer equal to target in the minimum number of moves. You may return any path that does so.

Example 1:
Input: target = "leet"
Output: "DDR!UURRR!!DDD!"

Example 2:
Input: target = "code"
Output: "RR!DDRR!UUL!R!"

(iii) Given an integer array nums, move all 0's to the end of it while maintaining the relative order of the non-zero elements.

Note that you must do this in-place without making a copy of the array.

Example 1:
Input: nums = [0,1,0,3,12]
Output: [1,3,12,0,0]
Example 2:
Input: nums = [0]

Output: [0]

Textbook(s):

3. E. Balagurusamy, *Programming in ANSI C*,8th ed.McGraw Hill, 2022
4. Debasis Samanta, *Classic Data Structures*, Prentice Hall India, 2nded. 2009

Reference Book(s):

6. Paul Deitel, Harvey Deitel, *C How to Program: With Case Studies Introducing Applications Programming and Systems Programming*, Pearson Education Limited, 9th ed. 2022
7. Brian W. Kernighan and Dennis Ritchie, *The C Programming Language*, Pearson

Education India, 2nd ed. 2015

8. Reema Thareja, *Data Structures Using C*, Oxford University Press, 2nd ed. 2014
9. Balagurusamy E, *Data Structure Using C*, McGraw Hill Education, 1st ed. 2017

Web and Video link(s):

3. 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.*
4. https://nptel.ac.in/courses/106106130; *NPTEL Video Lecture on Programming and Data Structures Dr. N. S. Narayana Swamy, CSE, IIT Madras.*

Laboratory Manual:

PROGRAMMING SKILL DEVELOPMENT LAB – 2 *Laboratory Manual,* Department of ECE, KITSW.

Course Articulation Matrix (CAM):				U24SE307:PROGRAMMING SKILL DEVELOPMENT LAB – 2									
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24SE307.1	3	2	1	1	3	-	-	-	-	1	-	2	1
CO2	U24SE307.2	3	3	2	2	3	-	-	-	-	1	-	2	2
CO3	U24SE307.3	3	3	3	3	3	-	-	-	-	1	-	3	2
CO4	U24SE307.4	3	3	3	3	2	-	-	-	-	1	-	3	3
U24SE307		3	2.75	2.25	2.25	2.75	-	-	-	-	1	-	2.5	2
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	Develop C programs using control structures, functions, arrays, strings, and recursion to solve basic computational problems.	SDG 4	Quality Education	Students gain foundational programming skills and computational thinking abilities, supporting quality technical education and lifelong learning
CO2	Apply problem-solving techniques and data structure concepts to design efficient algorithms for numerical and string processing applications.	SDG 4	Quality Education	Algorithm development and data structure implementation enhance analytical and problem-solving skills essential for modern engineering education
CO3	Implement and analyze solutions for real-world problems involving searching, sorting, dynamic programming, and mathematical computations.	SDG 9	Industry, Innovation and Infrastructure	Development of efficient computational solutions promotes innovation and technology-driven engineering applications
CO4	Develop optimized C programs and evaluate their correctness, efficiency, and applicability to engineering problem-solving.	SDG 9	Industry, Innovation and Infrastructure	Optimization and evaluation of software solutions contribute to technological advancement and sustainable digital infrastructure development

DIGITAL DESIGN LABORATORY

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24EC308**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1: build and test logic gates/adders on IC trainer boards

CO2: develop Verilog code for combinational and sequential circuits

CO3: examine memory functionality through HDL simulation

CO4: design a complete digital system using Verilog HDL

Experiment-1

1. Functional verification of logic gates

Experiment-2

1. Implementation and functional verification of adders and subtractors using logic gates

Experiment-3

1. Functional verification of 4x1 Multiplexer and 1x4 Demultiplexer

Experiment-4

1. Functional verification of Flip-flops

Experiment-5

1. Implementation and functional verification of shift registers

Experiment-6

1. Implementation and functional verification of Ring counter and Johnson Counter

Experiment-7

1. Implementation of all logic gates using Verilog HDL

Experiment-8

1. Implementation of half-adder & full-adder using Verilog HDL

Experiment-9

1. Implementation of 4x1 mux and 1x4 de-mux using Verilog HDL

Experiment-10

1. Implementation of all flip-flops using Verilog HDL.

Experiment-11

1. Implementation of 4-bit binary counter (synchronous &asynchronous) using Verilog HDL

Experiment-12

1. 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.Cilletti, "*Digital Design*", PHI, India, 4th ed. 2006
Web and Video link(s):
1. https://onlinecourses.nptel.ac.in/noc24_cs61/preview*NPTEL Video Lecture onDigital Design with Verilog by Prof. Chandan Karfa and Prof. Aryabartta Sahu, IIT Guwahati.*
Laboratory Manual:
*Digital Design Laboratory Manual and Record Book,*Department of ECE, KITSW

Course Articulation Matrix (CAM):				**U24EC308: DIGITAL DESIGN LABORATORY**									
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24EC308.1**	1	2	2	1	3	1	1	2	2	-	-	3	2
CO2	**U24EC308.2**	2	3	3	1	3	1	1	2	2	-	-	3	3
CO3	**U24EC308.3**	2	3	3	2	3	1	1	2	2	-	-	3	3
CO4	**U24EC308.4**	2	3	3	2	3	1	1	3	2	-	-	3	3
U24EC308		1.75	2.75	2.75	1.5	3	1	1	2.25	2	-	-	3	2.75
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	build and test logic gates/adders on IC trainer boards	SDG 4	Quality Education	Practical digital electronics learning.
CO2	develop Verilog code for combinational and sequential circuits	SDG 9	Industry, Innovation & Infrastructure	Verilog coding supports digital system innovation.
CO3	examine memory functionality through HDL simulation	SDG 9	Industry, Innovation & Infrastructure	Memory system verification supports advanced computing systems.
CO4	design a complete digital system using Verilog HDL	SDG 9	Industry, Innovation & Infrastructure	Complete digital system design contributes to technological development.

OBJECT ORIENTED PROGRAMMING THROUGH JAVALABORATORY

Class: B. Tech. III – Semester		**Branch:** ECE	
Course Code:	**U24EC309**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1: develop java fundamental programs using operators, control structures and arrays

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

CO3: build java programs on inheritance, dynamic method dispatch, interfaces and packages

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

Experiment-1

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-2

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-3

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

6. **Experiment-4**

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 staticblocks

Experiment-5

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-6
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-7
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-8
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-9
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-10
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-11
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-12
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*
Textbook(s):
1. HerbertSchildt, *Java TheComplete 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. KathySierra and BertBates, *Head First Java*, 2nd ed. Boston: O'Reilly Media,2005 3. Harvey Deitel and Paul J. Deitel, *Java How to Program,* 11thed. New Delhi: Pearson, 2018
Web and Video link(s): https://nptel.ac.in/courses/106105191*NPTEL Video Lecture on Java Programming* by Prof. Debasis Samanta,Professor of CSE, IIT Kharagpur

Course Articulation Matrix (CAM):		**U24EC309: OBJECT ORIENTED PROGRAMMING THROUGH JAVALABORATORY**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24EC309.1**	1	1	1	1	1	-	-	1	1	-	1	1	1
CO2	**U24EC309.2**	1	2	2	2	2	-	-	1	1	-	1	1	1
CO3	**U24EC309.3**	1	2	3	2	2	-	-	1	1	-	1	2	2
CO4	**U24EC309.4**	1	2	3	2	2	-	-	1	1	-	1	2	2
U24EC309		1	1.75	2.25	1.75	1.75	-	-	1	1	-	1	1.5	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	develop java fundamental programs using operators, control structures and arrays	SDG 4	Quality Education	Develops programming fundamentals through practice.
CO2	develop java programs using classes, constructors and various string concepts	SDG 4	Quality Education	Strengthens software development skills.
CO3	build java programs on inheritance, dynamic method dispatch, interfaces and packages	SDG 9	Industry, Innovation & Infrastructure	Encourages reusable and scalable software solutions.
CO4	develop java programs using I/O, exception handling and multithreading concepts	SDG 8	Decent Work & Economic Growth	Builds industry-ready software development competencies.

4th 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	3	1	-	4	4
6	VAC	U24VA406B	Soft and Interpersonal Skills[@]	-	-	2	2	1
7	PCC	U24EC408	Integrated Circuits Applications Laboratory	-	-	2	2	1
8	PCC	U24EC409	Communication Systems Laboratory	-	-	2	2	1
9	ESC	U24EC410	Python Programming Laboratory	--	-	2	2	1
10	VAC*	U24CY411*	Environmental Sciences*	2*	-	-	5*	-
			Total:	11	5	8	24	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:**	**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: 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

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&PracticalcharacteristicsofICµA741

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

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	
UNIT-IV	**9 Hrs**
Voltage Regulators: Basic voltage regulator using Op-Amps, General purpose IC regulator, μA723 - Functional diagram, Specifications, Three terminal voltage (fixed) regulators- General features and IC series of three terminal regulators **Data Converters:** DAC types - R-2R ladder; ADC types - Flash, Successive approximation & Dual slope **Phase Locked Loops (PLLs) (Qualitative treatment only):** Voltage controlled oscillator, Basic PLL operation, Definitions related to PLL, PLL application – FSK and AM detectors	
Textbook(s): 1. D.Roy Choudhury and Shail B Jain, "Linear Integrated Circuits", 4th ed. New Age International, 2010	
Reference Book(S): 1. Ramakant Gayakwad, "*Op-Amps and Linear Integrated Circuits*", 4th ed. Pearson Education, New Delhi, 2015 2. George B. Clayton, "*Linear Integrated Circuits and Applications*", The Macmillan Press Ltd., London, 1975 3. Rodert F.Coughlin and Frederick F.Driscoll, "*Operational Amplifiers and Linear Integrated Circuits*", 6th ed. Pearson Education, New Delhi, 2000 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): ps://onlinecourses.nptel.ac.in/noc24_ee73/preview*NPTEL Video Lecture on Integrated Circuits and Applications by Prof. Shaik rafi Ahamed, IIT Guwahati*	

Course Articulation Matrix (CAM):				**U24EC401: INTEGRATED CIRCUITS APPLICATIONS**										
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
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
U24EC401		**2**	**2**	**1**	**1**	**1.3**	**1.3**	**1**	**1**	**1**	**-**	**1**	**2.5**	**3**
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	analyze characteristics of Op-Amp IC741 using fundamental concepts	SDG 4	Quality Education	Understanding Op-Amp characteristics develops core electronics knowledge and engineering competency.
CO2	design Op-amp based simple linear & non-linear circuits for the given specifications	SDG 9	Industry, Innovation and Infrastructure	Design of linear and non-linear circuits supports innovation in electronic system development.
CO3	analyze Op-amp based active filters and IC 555 timer-based multivibrator circuits	SDG 9	Industry, Innovation and Infrastructure	Active filters and timer circuits are fundamental building blocks in modern electronic infrastructure.
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	SDG 9	Industry, Innovation and Infrastructure	PLLs, regulators and data converters are key components in communication and industrial systems.

COMMUNICATION SYSTEMS

Class: B.Tech. IV -Semester		**Branch:** ECE	
Course Code:	**U24EC402**	**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 Objectives (LOs):

This course will develop students' knowledge in /on…

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.

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

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

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

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

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

Course Articulation Matrix (CAM):					**U24EC402 COMMUNICATION 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
U24EC402		2	1.5	1	1	_	-	1	1	1	1	1	1	2
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	estimate the performance of AM systems, its generation and reception	SDG 4	Industry, Innovation and Infrastructure	AM communication systems contribute to communication infrastructure development.
CO2	evaluate the performance of FM system in the presence of noise and discuss pulse modulation techniques	SDG 9	Industry, Innovation and Infrastructure	FM and pulse modulation techniques enable reliable communication technologies.
CO3	determine code efficiency of source coding algorithms and different digital	SDG 9	Industry, Innovation and Infrastructure	Digital communication and coding techniques support advanced communication networks.
CO4	examine the performance of coherent band pass data transmission systems.	SDG 9	Industry, Innovation and Infrastructure	Band-pass digital transmission systems are essential for modern telecommunication infrastructure.

ELECTROMAGNETIC WAVES AND TRANSMISSION LINES

Class: B.Tech. IV -Semester		**Branch:** ECE	
Course Code:	**U24EC403**	**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):

This course will develop students' knowledge in /on…

CO1: electric field due to various charge distributions, energy stored in electrostatic field

CO2: magnetic field due to various current distributions, and wave propagation in different medium

CO3: prove pointing theorem, field components in rectangular & parallel plane waveguides

CO4: find voltage and current in a given transmission line and evaluate the impedance using smith chart

UNIT-I	9 Hrs

Review of vector calculus, co-ordinate systems - cartesian, cylindrical and spherical, statements of Stoke's theorem and Divergence theorem

Electrostatics: 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, Poisson's and Laplace's equations, Resistance and Capacitance.

UNIT-II	9 Hrs

Magnetostatics: 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

Time-Varying Fields: Continuity equation, Faraday's law of electromagnetic induction, inconsistency of Ampere's circuit law, Maxwell's equations in differential & integral forms

Electromagnetic waves: 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, Magnetic energy and Reflection of a plane wave at normal incidence

UNIT-III	9 Hrs

Power and Poynting Vector: Poynting vector, Poynting theorem, average Poynting vector and average power crossing a given surface

Waveguides: Rectangular waveguides – Field components, impossibility of propagation of TEM mode, TM mode propagation and propagation characteristics and introduction to circular wave guides, TE mode propagation in rectangular wave guide.

UNIT-IV	9 Hrs

Transmission Lines: Primary & Secondary constants, Transmission Line Equations, Infinite length transmission line, Phase velocity & Group velocity, Loss-less transmission line, Condition for distortion-less transmission line, Input impedance of a transmission line, Short-circuit & Open-circuit transmission lines, Quarter wave transformer, Smith chart –

Construction, Properties and Applications, Single-stub matching
Textbook(s): 1. Mathew N.O. Sadiku, "*Principles of Electromagnetics*", 4th ed. Oxford University Press, New York, 2014 2. Umesh Sinha "*Transmission Lines and Networks*", 2nd ed. Satya Prakashan Publication, New Delhi, 1999
Reference Book(s): 1. Edward C. Jordan, Keith G. Balmain,"*Electromagnetic Waves and Radiating Systems*", 2nded. Pearson Education, London, 2015 2. William H. Hayt, John A. Buck, Jaleel M. Akhtar, "*Engineering Electromagnetics*", 9th ed. The McGraw-Hill Companies, New York, 2020
Web and Video link(s): 1. *https://www.youtube.com/watch?v=0OwmYAljz4A&list=PL0925FD10648D664E;NPTEL Video Lecture on Electromagnetic Waves by Prof. R.K.Shevgaonkar, Dept of Electrical Engineering, IIT Bombay.* 2. *https://www.youtube.com/watch?v=G5P6dInMTFg&list=PLuv3GM6-gsE3-hVNaw-YEb7EeY5XVPZdz; NPTEL Video Lecture on Electromagnetic Theory by Prof. K. Pradeep Kumar, Dept of Electrical Engineering, IIT Kanpur.*

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														

CO–SDG Alignment Matrix

CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	electric field due to various charge distributions, energy stored in electrostatic field	SDG 4	Quality Education	Understanding electromagnetic fundamentals strengthens scientific and engineering education.
CO2	magnetic field due to various current	SDG 9	Industry, Innovation	Wave propagation principles are essential for communication and

	distributions, and wave propagation in different medium		and Infrastructure	wireless infrastructure.
CO3	**prove** pointing theorem, field components in rectangular & parallel plane waveguides	SDG 9	Industry, Innovation and Infrastructure	Waveguides and power transmission concepts support advanced communication systems.
CO4	find voltage and current in a given transmission line and evaluate the impedance using smith chart	SDG 9	Industry, Innovation and Infrastructure	Transmission line analysis is vital for telecommunications and power distribution networks.

COMPUTER ORGANIZATION AND MICROPROCESSORS

Class: B.Tech. IV -Semester		**Branch:** ECE	
Course Code:	**U24EC404**	**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):

This course will develop students' knowledge in /on…

CO1: interpret the basic components and examine the design of CPU, ALU and Control Unit
CO2: appraise computer arithmetic & input-output organization
CO3: adapt the architecture; make use of the instruction set, instruction formats and addressing modes of 8086
CO4: develop assembly language programs to solve problems

UNIT-I	**9 Hrs**

Digital Computers: Introduction, Block diagram of digital computer, Definition of computer organization, Computer design and computer architecture
Basic Computer Organization and Design: Instruction codes, Computer registers, Computer instructions, Timing and control, Instruction cycle, Memory reference Instructions, Input – Output and interrupt, Complete computer description
Micro Programmed Control: Control memory, Address sequencing, micro program example, Design of control unit.

UNIT-II	**9 Hrs**

Computer Arithmetic: Introduction, Addition and subtraction, Multiplication algorithms, Division algorithms, Floating - point arithmetic operations
Input-Output Organization: Peripheral devices, Input-Output interface, Asynchronous data transfer, Modes of Transfer, Priority interrupt, Direct memory access, Input –Output Processor (IOP), Intel 8089 IOP.

UNIT-III	**9 Hrs**

Central Processing Unit: 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
8086 Instruction Set and Assembler Directives: Machine language instruction formats, Addressing modes, Instruction set of 8086, Assembler directives and operators.

UNIT-IV	**9 Hrs**

Assembly Language Programming with 8086: 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

Textbook(s):

1. M. Moris Mano, *Computer System Architecture*, 3rd ed. Pearson. (Chapters 5,6,7,10,11)
2. K M Bhurchandi, A.K Ray , *Advanced Microprocessors and Peripherals*, 3rd edition, McGraw Hill India Education Private Ltd (Chapters 1,2,3,4)

Reference Book(s):
1. D V Hall, SSSP Rao, *Microprocessors and Interfacing*, 3rd ed. McGraw Hill India Education Private Ltd 2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: *Computer Organization*, 5th ed. Tata McGraw Hill, 2002 3. William Stallings, *Computer Organization and Architecture*, 9th ed. Pearson. 4. David A. Patterson, John L. Hennessy: *Computer Organization and Design – The Hardware / Software Interface ARM Edition*, 4th ed. Elsevier, 2009
Web and Video link(s):
1. https://archive.nptel.ac.in/courses/106/105/106105163*NPTEL Video Lecture: 1 on Evolution of Computer Systems* 2. https://archive.nptel.ac.in/courses/108/103/108103157*NPTEL Video Lecture: 3 on Functional Diagram of 8086* 3. https://archive.nptel.ac.in/courses/108/103/108103157*NPTEL Video Lecture:14 on Programs on Subroutines* 4. https://archive.nptel.ac.in/courses/106/105/106105163*NPTEL Video Lecture: 39 on FloatingPoint Arithmetic*

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														

CO–SDG Alignment Matrix

CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	interpret the basic components and examine the design of CPU, ALU and Control Unit	SDG 4	Quality Education	CPU and computer architecture concepts strengthen computing education and technical skills.
CO2	appraise computer arithmetic & input-output organization	SDG 9	Industry, Innovation and Infrastructure	Computer arithmetic and I/O systems form the basis of digital computing infrastructure.
CO3	adapt the architecture; make use of the instruction set, instruction	SDG 9	Industry, Innovation and	Microprocessor architecture supports embedded and industrial applications.

	formats and addressing modes of 8086		Infrastructure	
CO4	develop assembly language programs to solve problems	SDG 9	Industry, Innovation and Infrastructure	Assembly language programming enables development of innovative embedded solutions.

PYTHON PROGRAMMING

Class: B.Tech. IV -Semester		**Branch:** ECE	
Course Code:	**U24EC405**	**Credits:**	**4**
Hours/Week (L-T-P-E):	**3-1-0-4**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs):

This course will develop students' knowledge in /on…

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 data analysis

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

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

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 Exceptions, The finally Block, Re-raising exceptions, Assertions, *Multi threading*

File Handling: Opening and closing files, Reading and writing files, File positions, Renaming and deleting files, Directory methods

Database Connectivity: SQLite, creating a database table, Insert and retrieve data from database

UNIT-IV	**9 Hrs**

NumPy: The basics of NumPy arrays, Array indexing, Array slicing, Reshaping of array,

Concatenation and splitting arrays, Aggregations, Universal Functions, Broad casting of Arrays **Data Manipulation with Pandas:** 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 **Visualization with Matplotlib**: 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.
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/*NPTEL Video Lecture on Python For Data Science by By Prof. Ragunathan Rengasamy, IIT Madras* 2. https://onlinecourses.nptel.ac.in/noc25_cs17*NPTEL Video Lecture on Data Analytics with PythonBy Prof. A Ramesh, IIT Roorkee* 3. 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: 1. *Python Programming Laboratory Manual and Record Book,* Department of CSE, KITSW

Course Articulation Matrix (CAM):								**U24EC405: PYTHON PROGRAMMING**						
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	**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
U24EC405		**1.75**	2	**2**	2	**2.5**	1	-	-	-	1	1	2	2
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	develop python programs using control statements, operators and functions	SDG 4	Quality Education	Programming skills improve digital literacy and technical competence.
CO2	apply collections, namespaces, packages, strings and regular expressions in application development	SDG 8	Decent Work and Economic Growth	Application development skills improve employability and workforce readiness.
CO3	apply object-oriented programming principles in real-time problem solving	SDG 9	Industry, Innovation and Infrastructure	Object-oriented programming supports software innovation and scalable systems.
CO4	develop visualization graphs with Matplotlib and apply Numpy and Pandas libraries for data analysis	SDG 9	Industry, Innovation and Infrastructure	Data analysis and visualization contribute to data-driven innovation and decision-making.

SOFT AND INTERPERSONAL SKILLS LABORATORY

Class: B.Tech. IV-Semester		**Branch:** Common to all Branches	
Course Code:	**U24VA406B**	**Credits:**	**1**
Hours/Week (L-T-P-E):	**0-0-2-2**	**CIE:**	**100 %**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**-**

Course Learning Outcomes (COs):

This course will develop students' knowledge in /on…

CO1: deliver concise & effective self-introduction and demonstrate confidence, spontaneous speaking skills within a limited time

CO2: conduct a personal SWOT analysis to identify areas for self-improvement and career development

CO3: demonstrate clear & respectful communication, leadership, positive attitude and improve interpersonal relationship by actively participating in group discussions, collaborative tasks & mock interviews

CO4: create a professional resume, develop a LinkedIn profile and demonstrate effective video communication by making effective videos on self-introduction, personal SWOT analysis & spontaneous speaking activity along with email & workplace etiquette

LIST OF ACTIVITIES

Activity 1: Ice-breaking, Self-Awareness and Just a Minute (JAM)
Activity 2: Self-Introduction & Personal SWOT Analysis
Activity 3: Reading Comprehension & Critical Thinking
Activity 4: Active Listening & Non-Verbal Observation (Video + Peer Practice)
Activity 5: Group Discussion - 1
Activity 6: Resume Building & LinkedIn Profile Review
Activity 7: Group Discussion - 2
Activity 8: Presentation Skills with PPT / Storytelling
Activity 9: Group Discussion - 3
Activity 10: Mock Interviews: Technical & HR
Activity 11: Email Etiquette & Professional Communication
Activity 12: Workplace Etiquette & Conflict Resolution

Textbook(s):

1. Krishna Mohan & Meera Benerji, *Developing Communications Skills*, 2nd ed., New Delhi: Mcmillan Publications, 2005

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**	-	-

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	deliver concise & effective self-introduction and demonstrate confidence, spontaneous speaking skills within a limited time	SDG 4	Quality Education	Effective communication enhances lifelong learning and professional competence.
CO2	conduct a personal SWOT analysis to identify areas for self-improvement and career development	SDG 8	Decent Work and Economic Growth	SWOT analysis supports career planning and professional development.
CO3	demonstrate clear & respectful communication, leadership, positive attitude and improve interpersonal relationship by actively participating in group discussions, collaborative tasks & mock interviews	SDG 16	Peace, Justice and Strong Institutions	Teamwork, leadership and interpersonal skills promote inclusive and collaborative environments.
CO4	create a professional resume, develop a LinkedIn profile and demonstrate effective video communication by making effective videos on self-introduction, personal SWOT analysis & spontaneous speaking activity along with email & workplace etiquette	SDG 8	Decent Work and Economic Growth	Resume building, LinkedIn profiles and workplace etiquette improve employability.

INTEGRATED CIRCUITS APPLICATIONS LABORATORY

Class: B. Tech. IV – Semester		**Branch:** ECE	
Course Code:	U24EC408	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1: design and test the functionality of Op-amp circuits for linear applications such as differentiators and integrators

CO2: design and test the functionality of Op-amp circuits non-linear applications such as log amplifier and precision rectifier

CO3: amine the active filters using IC741

CO4: build and test the multivibrators using IC 555

Experiment-1

1. Design an inverting and non inverting amplifier using Op-Amp IC 741

Experiment-2

1. Design and testing of Adder and Subtractor circuits using IC 741

Experiment-3

1. Design and testing of differentiator using IC 741

Experiment-4

1. Design and testing of integrator using IC 741

Experiment-5

1. Design and testing of Instrumentation Amplifier using 3-Op-Amps IC 741

Experiment-6

1. Design and testing of log amplifier using Op-Amp IC 741

Experiment-7

1. Design and testing precision rectifier using Op-Amp IC 741

Experiment-8

1. Design and testing of Wien's bridge oscillator using IC 741

Experiment-9

1. Design and testing of astable multivibrator using IC 555

Experiment-10

1. Design and testing of monosatble multivibrator using IC 555

Experiment-11

1. Design and testing of second order active low pass filter using IC 741

Experiment-12

1. Design a voltage regulator using IC723

Textbook(s):

1. Rafael C. Gonzalez, Richard E. Woods,*Digital Image Processing*, Pearson, 4th edition, 2018, New York. *(Chapters 1 to 3, 9 to 12)*

Reference Book(S):
1. Anil K. Jain, *Fundamentals of Image Processing*, Pearson, 1st edition, 2015, Chennai. 2. B. Chanda, D. Dutta Majunder, *Digital Image Processing and Analysis*, Prentice Hall of India, 2nd edition, 2011, New Delhi. 3. S. Sridhar, *Digital Image Processing*, Oxford University Press, 2nd edition, 2016, Noida. 4. Munesh C. Trivedi, *Digital Image Processing*, Khanna Book Publishing, 1st edition, 2014, New Delhi.
Laboratory Manual
1. *Integrated Circuits Applications Laboratory Manual,* Department of ECE, KITSW

Course Articulation Matrix (CAM):		**U24EC408: 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	**U24EC408.1**	2	2	1	1	3	1	1	2	2	1	1	2	2
CO2	**U24EC408.2**	2	2	1	1	2	2	1	2	2	1	1	3	2
CO3	**U24EC408.3**	2	2	1	1	1	2	1	2	2	1	1	2	2
CO4	**U24EC408.4**	2	2	1	1	1	2	1	2	2	1	1	3	2
U24EC408		**2**	**2**	**1**	**1**	**2**	**1.75**	**1**	**2**	**2**	**1**	**1**	**2.5**	**2**
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	design and test the functionality of Op-amp circuits for linear applications such as differentiators and integrators	SDG 9	Industry, Innovation and Infrastructure	Practical circuit design skills support electronic innovation.
CO2	design and test the functionality of Op-amp circuits non-linear applications such as log amplifier and precision rectifier	SDG 9	Industry, Innovation and Infrastructure	Testing non-linear circuits develops engineering problem-solving abilities.
CO3	examine the active filters using IC741	SDG 9	Industry, Innovation and Infrastructure	Active filters are widely used in communication and industrial systems.
CO4	build and test the multivibrators using IC 555	SDG 9	Industry, Innovation and Infrastructure	Timer circuits are important in automation and control applications.

COMMUNICATION SYSTEMS LABORATORY

Class: B. Tech. IV – Semester		**Branch:** ECE	
Course Code:	**U24EC409**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1: determine the modulation index and percentage modulation of an AM carrier from the time domain curve plot

CO2: determine the modulation index and also measure the frequency deviation of an FMsignal

CO3: 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

CO4: analyse the amplitude, frequency and phase in different shift keying techniques

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

Textbook(s):
1. Rafael C. Gonzalez, Richard E. Woods,*Digital Image Processing*, Pearson, 4th edition, 2018, New York. *(Chapters 1 to 3, 9 to 12)*
Reference Book(S):
1. Anil K. Jain, *Fundamentals of Image Processing*, Pearson, 1st edition, 2015, Chennai. 2. B. Chanda, D. Dutta Majunder, *Digital Image Processing and Analysis*, Prentice Hall of India, 2nd edition, 2011, New Delhi. 3. S. Sridhar, *Digital Image Processing*, Oxford University Press, 2nd edition, 2016, Noida. 4. Munesh C. Trivedi, *Digital Image Processing*, Khanna Book Publishing, 1st edition, 2014, New Delhi.
Laboratory Manual :
1. *Communication Systems Laboratory Manual,* Department of ECE, KITSW

Course Articulation Matrix (CAM):					**U24EC409: COMMUNICATION SYSTEMS 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	**U24EC409.1**	2	1	1	1	-	-	1	1	1	1	1	1	2
CO2	**U24EC409.2**	2	1	1	1	-	-	1	1	1	1	1	1	2
CO3	**U24EC409.3**	2	1	1	1	-	-	1	1	1	1	1	1	2
CO4	**U24EC409.4**	2	1	1	1	-	-	1	1	1	1	1	1	2
U24EC409		**2**	**1**	**1**	**1**	**-**	**-**	**1**	**1**	**1**	**1**	**1**	**1**	**2**
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	determine the modulation index and percentage modulation of an AM carrier from the time domain curve plot	SDG 9	Industry, Innovation and Infrastructure	AM signal analysis strengthens practical communication engineering skills.
CO2	determine the modulation index and also measure the frequency deviation of an FM signal	SDG 9	Industry, Innovation and Infrastructure	FM signal experimentation supports communication technology development.
CO3	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	SDG 9	Industry, Innovation and Infrastructure	PCM and DM experiments are fundamental to digital communication systems.
CO4	analyse the amplitude, frequency and phase in different shift keying techniques	SDG 9	Industry, Innovation and Infrastructure	Shift keying techniques are essential in modern wireless and digital networks.

PYTHON PROGRAMMING LABORATORY

Class: B. Tech. IV – Semester		**Branch:** ECE	
Course Code:	U24EC410	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1: implement and test python programs using operators, control statements & functions

CO2: Implement and test python packages using string handling methods, regular expressions, and collections

CO3: implement and test object oriented paradigms and database operations in Python programming

CO4: build visualization graphs with Matplotlib and adapt packages like Numpy, Pandas for data analysis

Experiment-1

1. Installation of Python and verifying PATH environment variable
2. Running instructions in Interactive interpreter and a python script
    a. Executing instructions in Python Interactive Interpreter
    b. Running python scripts in Command Prompt
    c. Running python scripts in IDLE
3. Develop a Python program to demonstrate importance of indentations. Purposefully raise indentation error and correct it
4. Develop a Python program to take input text as command line argument and display it on screen

Experiment-2

1. Develop a Python program that takes 2 numbers as command line arguments and print its sum
2. Develop a Python program to check whether the given number is even or odd
3. Develop a Python program to calculate GCD of 2 numbers
4. Develop a Python program to find Exponentiation (Power) of a number
5. Develop a Python program to find given year is leap year or not
6. Develop a Python program to develop a simple calculator

Experiment-3

1. Develop a Python program to find the Factorial of a given number
2. Develop a Python program to find the Armstrong for a given number
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-4

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-5
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-6
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-7
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-8
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-9
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-10
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-11
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-12
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. Rafael C. Gonzalez, Richard E. Woods,*Digital Image Processing*, Pearson, 4th edition, 2018, New York. *(Chapters 1 to 3, 9 to 12)*
Reference Book(S): 1. Anil K. Jain, *Fundamentals of Image Processing*, Pearson, 1st edition, 2015, Chennai. 2. B. Chanda, D. Dutta Majunder, *Digital Image Processing and Analysis*, Prentice Hall of India, 2nd edition, 2011, New Delhi. 3. S. Sridhar, *Digital Image Processing*, Oxford University Press, 2nd edition, 2016, Noida. 4. Munesh C. Trivedi, *Digital Image Processing*, Khanna Book Publishing, 1st edition, 2014, New Delhi.
Laboratory Manual: 1. *Python Programming Laboratory Manual,* Department of ECE, KITSW

Course Articulation Matrix (CAM):								**U24EC410 PYTHON PROGRAMMING 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	**U24EC410.1**	1	2	2	2	2	1	1	1	1	1	2	2	2
CO2	**U24EC410.2**	2	2	2	2	2	1	1	1	1	1	2	2	2
CO3	**U24EC410.3**	2	2	2	2	3	1	1	1	1	1	2	2	2
CO4	**U24EC410.4**	2	2	2	2	3	1	1	1	1	1	2	2	2
U24EC410		**1.75**	**2**	**2**	**2**	**2.5**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**
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	implement and test python programs using operators, control statements & functions	SDG 4	Quality Education	Practical programming exercises improve computational thinking and digital skills.
CO2	Implement and test python packages using string handling methods, regular expressions, and collections	SDG 8	Decent Work and Economic Growth	Software development skills enhance employability and technical competency.
CO3	implement and test object oriented paradigms and database operations in Python programming	SDG 9	Industry, Innovation and Infrastructure	Database and OOP applications support software innovation and digital transformation.
CO4	build visualization graphs with Matplotlib and adapt packages like Numpy, Pandas for data analysis	SDG 9	Industry, Innovation and Infrastructure	Data analytics and visualization tools enable innovation and evidence-based decision making.

ENVIRONMENTAL STUDIES

Class:B.Tech.IV Semester		**Branch:**CommontoCE, EEE, ECIE, ECE & CSE	
CourseCode:	**U24CY411**	**Credits:**	**0**
Hours/Week(L-T-P-E):	**2-0-0-2**	**CIE:**	**60%**
TotalNumberofTeachingHours:	**24Hrs.**	**ESE:**	**40%**

CourseLearningOutcomes(COs):
Thiscourse willdevelopstudents' knowledgein/on…

CO1: identifythe naturalresources and practice their usage more equitably

CO2:developanactionplanforsustainablealternativesandconserving biodiversity

CO3:examine and perceive the solutions for the environmental pollution

CO4:adapt issues involved in enforcement of environmental legislation and green methodology

UNIT-I	**6Hrs**

The Multidisciplinary Nature of Environmental Studies: Definition, Scope and importance

Natural Resources: 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

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)*

UNIT-II	**6Hrs**

Ecosystem and Biodiversity:

Ecosystem: Concepts of an ecosystem, Food chain, Food webs, Ecological pyramids, Energy flow in the ecosystem and ecological succession

Biodiversity and its Conservation: 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

Self-Learning Topics (SLTs): *Introduction and definition of biodiversity (Text1: unit 4, topic 4.1)*

UNIT-III	**6Hrs**

Environmental Pollution: Global Issues-Global climatic change, Greenhouse gases, Effects of global warming, Ozone layer depletion

International Conventions/Protocols: Earth summit, Kyoto protocol, Montreal protocol **Environmental Pollution-**Causes and effects of air, Water, Soil, Marine and noise pollution with case studies

Solid and Hazardous Waste Management: Introduction, Types, Effects of urban industrial and nuclear waste

Natural Disaster Management: Introduction to disaster, Management of disaster, Disaster

management of flood, earthquake, cyclone and landslides Role of information technology in environment and human health ***Self-Learning Topics (SLTs):*** *Role of individual in prevention of pollution (Text1: unit 5, topic 5.10)*	
UNIT-IV	**6Hrs**
Social Issues and the Environment: Role of Individual and Society, Water conservation, Rain water harvesting **Environmental Protection/Control Acts:** 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 **Green Methodology:** Principles of green chemistry, green methods in electronic production, Impact of electronic waste on public health and environment;United nations goals of sustainable development ***Self-LearningTopics(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)*	
Textbook(s): 2. ErachBharucha,*TextBook of EnvironmentalStudies for UnderGraduateCourses,*2nded.UniversitiesPress(India)Pvt.Ltd,2013	
ReferenceBook(s): 5. Y. Anjaneyulu, *Introduction to Environmental Science*, B.S. Publications, 2004 6. Gilbert M. Masters, *Introduction to Environmental Engineering & Science*, 3rded. Prentice Hall of India,1991 7. Anubha Kaushik, C.P. Kaushik, *Environmental Studies*, 4thEdition, New Age International Publishers,2014 8. R. Rajagopalan, *Environmental Studies from crisis to cure*, Oxford University Press, 2nded. 2011	
Weband Videolink(s): **2.** 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*	

CourseArticulationMatrix(CAM):		U24CY411: ENVIRONMENTAL STUDIES												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24CY411.1	2	1	2	1	-	2	1	1	1	1	1	1	1
CO2	U24CY411.2	-	-	2	1	-	1	1	1	1	1	1	1	1
CO3	U24CY411.3	1	2	1	1	-	1	1	1	1	1	1	1	1
CO4	U24CY411.4	-	-	1	1	-	2	1	1	1	1	1	1	1
	U24CY411	**0.75**	**0.75**	**1.50**	**1**	**-**	**1.5**	**1**	**1**	**1**	**1**	**1**	**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	identifythe naturalresources and practice their usage more equitably	**SDG 12**	Responsible Consumption and Production	Promotes sustainable utilization, conservation, and equitable distribution of natural resources to minimize resource depletion.
CO2	developanactionplanforsustainablealternativesandconserving biodiversity	**SDG 15**	Life on Land	Focuses on biodiversity conservation, ecosystem protection, and adoption of sustainable alternatives to preserve terrestrial life.
CO3	examine and perceive the solutions for the environmental pollution	**SDG 13**	Climate Action	Understanding pollution control measures contributes to mitigating environmental degradation and combating climate change impacts.
CO4	adapt issues involved in enforcement of environmental legislation and green methodology	**SDG 16**	Peace, Justice and Strong Institutions	Environmental laws, policies, and governance mechanisms promote sustainable development through effective institutions and regulatory frameworks.

2nd Year Exit Courses Syllabus

Bridge Courses for exit:

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

OR

Successful completion of twosuitable 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 UG Diploma 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	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 andDean AA	2	-	2	-	4	3

(OR)

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

Exit Option to Qualify UG Diploma in ECE: 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 https://www.essc-india.org/images/QPs/Digital%20Cable%20Technician%20-%20Access%20-%20ELE_Q8106_v4.0.pdf	-	-	6	-	6	3
2	SEC	U24SE413X	Arduino Based Embedded System Design https://www.nielit.gov.in/sites/default/files/headquarter/Certificate%20Course%20in%20ARDUINO%20based%20Embedded%20System%20Design.pdf	-	-	6	-	6	3
3	SEC	U24SE414X	VLSI Design using EDA Tools	-	-	6	-	6	3

			https://www.nielit.gov.in/sites/default/files/Delhi/VLSI%20DESIGN%20AND%20TOOL.pdf						
4	SEC	U24SE415X	Optical fiber Technicianhttps://rajshaladarpan.nic.in/sd2/Home/Public2/VocationalSchool/Curriculum/11th_12th_Telecom.pdf	-	-	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-E):	**2-0-2-4**	**CIE:**	**60%**
TotalNumberofTeachingHours:	**32 Hrs**	**ESE:**	**40%**

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

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

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

LABORATORYCOMPONENT

ListofExperiments:

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)

Textbook(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:

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

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%**

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.

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

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, *Internet of Things: A Hands-on Approach*, Universities Press.
2. Bharat Bhushan, Bhuvan Unhelkar, *Internet of Things (IoT): Principles, Paradigms and Applications of IoT*, Springer.
3. Peter Waher, *Mastering Internet of Things: Design and create your own IoT applications using 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:

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

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

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 Adder 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; *NPTEL Video Lecture on VLSI DESIGN &TECHNOLOGY by By Prof. Avishek Chatterjee| IIT Kharagpur*

Laboratory Manual :

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

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														

5th 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** *The student should be able to…*	**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.

<u>TextBook(s):</u>

1. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, Tata McGraw-Hill, 10th Edn, 2012, New Delhi.

<u>Reference Book(s):</u>

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		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PSO 1**	**PSO 2**
CO 1	**U24OE501 B.1**	2	2	1	1	1	1	-	1	1	-	1	-	1
CO 2	**U24OE501 B.2**	1	2	2	2	1	1	1	1	1	-	1	-	1
CO 3	**U24OE501 B.3**	1	2	3	2	2	1	1	1	1	1	1	-	1
CO 4	**U24OE501 B.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** *The student should be able to…*	**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	SDG 8	Decent Work and Economic Growth	Supports entrepreneurship, innovation-driven business models, and employability

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
	using structural validation, risk analysis, and engineering metrics			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.

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**

Introduction to Entrepreneurship: definitions, characteristics, and the evolution of an entrepreneurial ecosystem; Myths vs. Realities of starting up; Types of entrepreneurship (Social, Tech, Lifestyle, and Corporate);

Developing an entrepreneurial mindset: risk-taking, resilience, self-efficacy, and dealing with failure; Identifying personal strengths and alignment with venture archetypes.

UNIT-II	**9 Hrs**

Deep-dive Problem Identification: moving from generic ideas to systemic problems; Root-cause analysis, stakeholder mapping, and ecosystem friction points;

Customer Discovery methodology: 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**

Designing the business architecture: Introduction to the Lean Canvas and Business Model Canvas (BMC); Revenue streams, pricing strategies, and cost structures;

Fundamentals of Unit Economics: 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**

Building the Go-To-Market (GTM) strategy: 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**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
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** *The student should be able to…*	**Relevant 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 points using structured customer discovery techniques	SDG 3	Good Health and Well-being	Facilitates the identification and validation of healthcare-related needs, leading to more user-centric and 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	SDG 9	Industry, Innovation and	Strengthens innovation ecosystems by enabling the commercialization and

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
	business modeling, unit economics, and venture monetization		Infrastructure	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.

5. 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**	**PO10**	**PO11**	**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		1.25	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	**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 SDGs**		**Justification**
	assumptions via stakeholder co-creation and design an institutional go-to-market plan.		and Economic Growth	driven employment, and sustainable economic growth through market-oriented solution development.
		SDG 9	Industry, Innovation and Infrastructure	Strengthens industry-academia innovation ecosystems by facilitating the translation of validated technologies into scalable solutions.
		SDG 17	Partnerships for the Goals	Encourages collaboration among academia, industry, government, and end users to co-create impactful and sustainable innovations.

LINEAR CONTROL SYSTEMS

Class: B.Tech. V -Semester		**Branch:** ECE	
Course Code:	**U24EC502**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE Marks :**	**60 %**
Total Number of Teaching Hours:	**36Hrs**	**ESE Marks :**	**40 %**

Course Learning Outcomes (COs):

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

CO1: determine transfer function of dynamical systems using block diagram and signal flow graph methods

CO2: determine the time-domain specifications of first & second-order systems and compare the performance of P, PI, PD and PID controllers

CO3: assess system stability in both time and frequency domains

CO4: formulate the state-space model of a given physical system and explore the fundamental concepts of compensators

UNIT-I	9 Hrs

Concepts of Control systems: 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

UNIT-II	9 Hrs

Control System Components: AC & DC Servomotors, Synchro's

Time Response Analysis: 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

UNIT-III	9 Hrs

Stability Analysis: 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) onthe root loci

Frequency Response Analysis: 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

UNIT-IV	9 Hrs

Control System Analysis using State Variable Method: 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

Compensation: Introduction, Elementary treatment of lead, Lag and lead-lag compensation

TextBook(s):

1. A. Anand Kumar, *Control Systems*, 2nd ed., New Delhi: Prentice Hall of India, 2014

Reference Book(s):

1. I.J.Nagrath& M. Gopal, *Control Systems Engineering*, 4th ed., New Delhi: New Age International

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

Web and Video link(s):

https://nptel.ac.in/courses/108106098//; *NPTEL Video Lecture onControl Engineering by Prof. Ramkrishna Pasumarthy, 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** *The student should be able to…*	**Relevant SDG**	**SDG 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

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

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

UNIT-I	**9 Hrs**

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

UNIT-II	**9 Hrs**

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.

UNIT-III	**9 Hrs**

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
ARM7 Based Microcontroller LPC2148: 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, & PLLSTAT, and PLLFEED. PLL frequency Calculation- procedure for determining PLL settings, examples for PLL Configuration Timers-Features, applications, Architecture of timer module, register description. **Programming of LPC2148:** C programs for General purpose I/O, interfacing with LED, general purpose timer, PWM modulator, UART	

Textbook(s):

1. K. J. Ayala, D. V. *The 8051 Microcontroller & Embedded Systems using Assembly and C*, Gadre, Cengage Learning *(Chapters 1 to 7, 9 to 12)*
2. Sloss, Andrew, Dominic Symes, and Chris Wright. ARM system developer's guide: designing and optimizing system software. Elsevier,2004
3. LPC2148 User manual

Reference Book(s):

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay *the 8051 Microcontroller and Embedded Systems Using Assembly and C*, 2nd Edition, Pearson Education
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", TMH Publications, Second Edition, 2008.
3. Furber, Stephen Bo. ARM system-on-chip architecture, New Delhi: Pearson Education,2000
4. Predko M., *Programming and Customizing the 8051 Microcontroller*, McGraw-Hill, 1999

Web and Video link(s):

1. https://nptel.ac.in/courses/108105102;NPTEL Video Lecture on Microprocessors and Microcontrollers by Prof. Santanu Chattopadhyay, Professor of EEE, IIT Kharagpur.
2. http://www.digimat.in/nptel/courses/video/117106111/L03.html
3. https://www.youtube.com/playlist?list=PLbMVogVj5nJRDS4w20GO7l4SepLhuAj9X
4. https://youtu.be/s00xmJA5CXY?si=bpzHDSpMZE-9LPjS

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** *The student should be able to…*	**Relevant SDG**	**SDG 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 serialcommunicationor interrupt operationare 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%**

Course Learning Outcomes (COs)

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

CO1 : Explain MOS fabrication processes and Analyze the electrical characteristics of MOS transistors and CMOS inverter circuits.

CO2 : Apply VLSI layout design concepts including stick diagrams, design rules, scaling and basic circuit parameters in CMOS circuits.

CO3 : Design and Analyze CMOS digital subsystems using arithmetic building blocks, switch logic and dynamic CMOS logic techniques.

CO4 : Analyze and design analog CMOS building blocks such as amplifiers, current mirrors, and differential pairs using small signal models.

UNIT-I	9 Hrs

Introduction to MOS Technology: Introduction to IC technology, Evolution of VLSI, Basic MOS transistor, Process steps in fabricating MOSFET, Fabrication process of nMOS, CMOS and BiCMOS transistors.

Basic Electrical Properties of MOS Transistor: 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

MOS Circuit Design Processes: 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.

Basic Circuit Concepts: Sheet resistance, Area capacitances of layers, Delay unit, Inverter delays, Rise time and Fall time estimation

UNIT-III	9 Hrs

Data path Subsystems: Introduction, architectures for adders, multipliers, and shifters, speed and area trade-offs, One/ Zero detector, comparators.

Switch and Dynamic CMOS logic: Pass transistor and CMOS transmission gates, Pseudo nMOSlogic,Dynamic CMOS logic, Domino CMOS Logic.

UNIT-IV	9 Hrs

Analog IC Building Blocks: Analysis of MOSFET small signal model**,**Qualitative Analysis ofCommon 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; *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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. V – Semester		**Branch:** ECE	
Course Code:	**U24EC505**	**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 : 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.

CO2 : apply regression and classification algorithms to build models and evaluate their performance.

CO3 : analyze clustering methods and neural network models for pattern recognition and data analysis.

CO4 : explain ANN, DNN, CNN, RNN, LSTM fundamentals, back propagation, applications, and performance issues

UNIT-I	9 Hrs

Introduction to AI: Definition, history, applications, advantages and limitations of AI

Introduction to Machine Learning: Definition, history, applications, advantages, types of learning - Supervised, Unsupervised and Reinforcement learning, ML workflow, underfitting & overfitting, performance metrics for regression with R^2 and Mean Squared Errorand performance metrics for classification with Confusion Matrix, Accuracy, Precision, Recall and F1-score

Datasets: Types of datasets, dataset components, dataset formats, data exploration, handling missing values, feature scaling and train-test split.

UNIT-II	9 Hrs

Supervised Learning: 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

UNIT-III	9 Hrs

Unsupervised Learning: 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

UNIT-IV	9 Hrs

Artificial Neural Networks (ANN): 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

Network and introduction to LSTMs
TextBook(s): 1. Andreas C. Müller , Sarah Guido, *Introduction to Machine Learningwith Python – A guide for data scientists,* O'Reilly Media, 1st edition, 2016, California. 2. Satish Kumar, *Neural Networks – A Classroom Approach*, McGraw Hill Education, 2nd edition, 2017, India.
Reference Book(s): 1. Jiawei Han, Micheline Kamber, Jian Pei, *Data Mining: Concepts and Techniques*, 3rd 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*, 2nd 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=PLVedk3nRvxDScQQpgMS6PBqV2lEeXJSLj; *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** *The student should be able to…*	**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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B.Tech. V Semester	**Branch:**Common to all		
Course Code:	U24IK506A	**Credits:**	-
Hours/Week (L-T-P-E):	**2-0-0-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : summarize the basic structure of Vedas, Upavedas, Vedanga, Upanga

CO2 : explain Vedas as principal source of knowledge for scientific inventions

CO3 : describe different yogasanas, breathing techniques, chakras, meditation and their benefits

CO4 : discuss the benefits of yoga as an effective tool for management of human crisis

UNIT-I	**6 Hrs**

Basic Structure of Indian Knowledge System:
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

UNIT-II	**6 Hrs**

Modern Science and Indian Knowledge System:
Introduction, Vedas as basis for modern science, architectural developments, medicine and its relevance, mathematical sciences in Vedas, space and military related developments, chemical sciences

UNIT-III	**6 Hrs**

Yoga and Holistic Health Care:
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.

UNIT-IV	**6 Hrs**

Case Studies – Yoga Practice:
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.

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 Chaterjee, Dhirendramohan Datta, *An Introduction to Indian Philosophy*, New Delhi: Rupa Publications Pvt. Ltd. (Chapter 2, 3). 2. Priyadaranjan 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 Jitatmananda, *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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

TECHNICALENGLISH

Class:B.Tech.VSemester		**Branch:**CommontoallBranches	
CourseCode:	**U24MH507**	**Credits:**	**1**
Hours/Week(L-T-P-E):	**0-0-2-2**	**CIE:**	**100%**
TotalNumberofTeaching Hours:	**24Hrs**	**ESE:**	**-**

CourseLearningOutcomes(COs)

Aftercompletionofthiscourse,thestudentsshouldbeableto,

C developeffectivelistening,speaking,readingandwritingskillsbyunderstandingnative-speakerconversationsandexpressingideasclearlyandconfidentlyusingappropriate vocabulary, while maintaining fluency, coherence and accurate pronunciation.

C enhancecommunicationandprofessionalwritingskillsthroughpodcastcomprehension,groupdiscussions,resumeandemailwriting

C developtheabilitytounderstand readingtexts,conversationsofbothnativeandnon-nativespeakers,interpretvisualinformation,andproduceclearandwell-structuredtechnical reports.

C developtheabilitytoperformwellininterviewsandpresenteffectivelywithclarityofspeechandappropriateaccent.

Activity-12hrs

Phonetic Foundations, Authentic Audio-Visual Comprehension & Vocabulary Enhancement: SpeechSounds- Phonemes (Vowels and consonant sounds),word stress, syllables - their role and importance in spoken English, **Authentic Audio-Visual Comprehension**: Movie Clips - Screening of a short native-speaker clip - context comprehension, focus attention on accent features and key expressions,**Vocabulary:**WordFormation-Prefixes-Suffixes.

Activity: Practice pronunciation through Read-Record-Reflect, analyze audio-visual content for comprehension and expression usage.

Activity-2 **2hrs**

Story Narration, Writing Skills and Vocabulary Enhancement- Narrative structure (beginning, build-up, climax, conclusion), Cohesive devices, Voice modulation & Expression. **Writing:**PrinciplesofParagraphWriting-ImportanceofCoherenceinWriting-Cause and Effect Paragraphs. **Vocabulary:** Synonyms and antonyms.

Activity: 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.

Activity - **2hrs**
Reading Comprehension, Vocabulary Enhancement & Elocution Skills- **Reading Comprehension:** Main idea identification, interpretation, critical analysis. **Vocabulary Enhancement**: One-word substitutes.**Elocution:** Speech delivery skills (organisation, voice modulation, fluency, pronunciation, and audience engagement). **Activity:** 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.
Activity-4 **2hrs**
Think–Pair–Share Conversation (Podcast-Based), **Vocabulary Enhancement:** 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 **Vocabulary Enhancement**: Idioms in context and usage **Activity**: 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
Activity-52hrs
Group Discussion, Vocabulary Enhancement: GD format and roles, rules of participation, **Vocabulary** – Word Pairs, commonly confused words **Activity:** Engage in group discussions focusing on clear expression and interactionand word pair exercises
Activity -62hrs
Reading Comprehension, Visual Interpretation & Vocabulary Enhancement: Skimming and scanning, identifying main and supporting ideas, distinguishing fact and opinion. **Visual Interpretation:** Interpreting visual cues, logical sequence. **Vocabulary**: Phrasal Verbs: separable and inseparable forms, and contextual usage. **Activity:** 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
Activity-72hrs

Motivational Speeches, Presentation Skills & Vocabulary Enhancement: identifying central theme and tone, note-taking, Narrative techniques. **Presentation** – Speak to Inspire- topic selection, structure (introduction–body–conclusion), **Vocabulary Enhancement** – Collocations- Introduction to collocations, types of collocations, and contextual usage **Activity**: 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
Activity-82hrs
Writing & Vocabulary Enhancement: Professional Resume Writing techniques, Action verbs in resume writing, Letterof Application, E-mail Etiquette—vocabulary: Jumbled sentences **Activity**: 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
Activity-92hrs
Reading Comprehension, Newspaper Reading & Vocabulary Enhancement: Intensive reading , Extensive reading, Newspaper reading:5W1H method, Summarization, vocabulary building **Activity:** 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
Activity-10 **2hrs**
PowerPoint Presentations: Concept and purpose of presentations, layout and structure (title, introduction–body–conclusion), slide design elements, visual aids, common mistakes to avoid **Activity:** 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

1. https://www.youtube.com/watch?v=5SfQhkMsUFk&list=PLA7lNLNvxTzig5dqfGl8DGbLOvUI08yXg&index=2

2. Learn English with WRECK-IT RALPH
https://www.youtube.com/watch?v=wVhG59zh4uQ&list=PLA7lNLNvxTzig5dqfGl8DGbLOvUI08yXg&index=4

3. ThePursuitofHappiness(2006):MostPowerfulMoments!
https://www.youtube.com/watch?v=TkD1QvjKlqU

4. **Podcastby**RaulJohn"InsidetheMindofIndia'sAIKid".BusinessToday
https://www.youtube.com/watch?v=biCrIlhZrC4

5. Podcast bySudhaMurthy-So What IfILosttheBattle,ILived theWar | TheRanveerShow
https://www.youtube.com/watch?v=KwXtalUuhLc

6. MotivationalTalk byGourGopalDas,SLEEPLESSNightsforOvernight SUCCESS
https://www.youtube.com/watch?v=YyCXp_E4sMU

7. MotivationalTalk byAdmiralMcRaven'sSpeechforYourDay,"5MinutestoStartYourDay Right! - MORNING MOTIVATION"
https://www.youtube.com/watch?v=b-Pn0yXL9y8

LaboratoryManual:

1. TechnicalEnglishManualpreparedbythefacultyofEnglish,KITSW.

CourseArticulationMatrix(CAM):		**U24MH507:**TechnicalEnglish												
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–SDGAlignment Matrix

CO	**CO Statement** *Thestudentshouldbeable to*	**Relevant SDG**	**SDG Description**	**MappingJustification**
CO1	develop effective listening, speaking, reading and writing skills by understanding native- speaker	SDG4	Quality Education	ThisalignswithSDG-4asitdevelops effective listening, speaking, reading and writingskills 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,coherencean daccurate pronunciation.			vocabulary and pronunciation to promote quality education
CO2	enhance communication and professional writing skills throughpodcast comprehension,group discussions, resume and Quality Education email writing	SDG 4, 8	Quality Educatio n & Decentwor k and Economic growth	ThisalignswithSDG-4asitpromotes quality education by enhancing employability skills and professional writing skills through podcast comprehension, resume writing, critical reading and group discussion This aligns with SDG-8 as it helps students expect productive employment and decent work opportunitiesbyfosteringacademic and creative thinking
CO3	develop the ability to understand reading texts, conversations of both nativeand non-native speakers, interpret visual information,andprod uceclearandwell-structuredtechnicalre ports	SDG4	Quality Educatio n	This aligns with SDG-4 as it develops theabilitytointerpret visualinformation 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	SDG4	Quality Educatio n	ThisalignswithSDG-4asitenhances effective presentation skills and perform well in interviews

MICROCONTROLLERS AND APPLICATIONS LABORATORY

Class: B. Tech. V – Semester			**Branch:** ECE
Course Code:	**U24EC508**	**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: Analyze and execute 8051 microcontroller assembly language programs for arithmetic, data manipulation, sorting, searching, and code conversion operations.

CO2 : Design and implement ARM7TDMI assembly language programs for arithmetic computations, data processing, and mathematical problem solving.

CO3: Develop embedded applications using LPC2148 for GPIO-based interfacing and control of LEDs, buzzers, and digital I/O devices.

CO4: Design and implement real-time embedded control applications using LPC2148 for interfacing and controlling stepper motors.

Hardware Experiments:

Experiments-1

1. Microcontroller 8051 based Assembly language programs for simple 8-bit Arithmetic operations (Addition, Subtraction, Multiplication and Division).

Experiments-2

2. Microcontroller 8051 based Assembly language programs to find largest/Smallest Number in an array

Experiments-3

3. Microcontroller 8051 based Assembly language programs to sort given series of numbers in Ascending/Descending order

Experiment-4

4.Microcontroller 8051 based Assembly language programs to transfer of byte from one location to another.

Experiment-5

5.Microcontroller 8051 based Assembly language program for Code Conversion Program Hexa decimal to ASCII.

Experiment-6

6.ARM7TDMI based Assembly language programs to perform simple 8-bit Arithmetic operations (Addition, Subtraction, Multiplication and Division).

Experiment-7

7.ARM7TDMI based Assembly language program to perform Swapping of two Number & finding factorial of given number

Experiment-8

8.ARM7TDMI based Assembly language program to evaluate linear equation.

Experiment-9
9.Write a program for Flashing of LEDS using LPC2148.
Experiment-10
10.Write a Program to interface Buzzer using LPC2148
Experiment-11
11. Write a Program to interface Digital I/O Using LPC2148
periment-12
12. Write a program to Interface stepper motor using LPC2148

Textbook(s):

1. K. J. Ayala, D. V. *The 8051 Microcontroller & Embedded Systems using Assembly and C*, Gadre, Cengage Learning *(Chapters 1 to 7, 9 to 12)*
2. Sloss, Andrew, Dominic Symes, and Chris Wright. ARM system developer's guide: designing and optimizing system software. Elsevier,2004.
3. LPC2148 User manual

Reference Book(s):

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay *the 8051 Microcontroller and Embedded Systems Using Assembly and C*, 2nd Edition, Pearson Education
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", TMH Publications, Second Edition, 2008.
3. Furber, Stephen Bo. ARM system-on-chip architecture, New Delhi: Pearson Education,2000.
4. Predko M., *Programming and Customizing the 8051 Microcontroller*, McGraw-Hill, 1999

Web and Video link(s):

1. https://www.youtube.com/watch?v=qWqlkCLmZoE&utm_source=chatgpt.com
2. http://www.digimat.in/nptel/courses/video/117106111/L03.html
3. https://www.youtube.com/playlist?list=PLbMVogVj5nJRDS4w20GO7l4SepLhuAj9X

Laboratory Manual:
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** *The student should be able to…*	**Relevant SDG**	**SDG 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	Developsfundamental 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	Developembedded 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 advancementof 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

VLSI DESIGN LABORATORY

Class: B. Tech. V – Semester		**Branch:** ECE	
Course Code:	**U24EC509**	**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 : Analyze the characteristics and operation of MOSFET and basic CMOS inverter.

CO2 : Design and verify the functionality of CMOS logic gates using schematic and layout design techniques.

CO3 : Design and verify the functionality of CMOS combinational circuits using schematic and layout design techniques.

CO4 : Design and analyze the common source amplifiers, current mirrors, and basic differential amplifiers using MOS schematic.

Experiment-1

4. MOSFET characterization using cadence EDA.

Experiment-2

5. Schematic of CMOS inverter and its VTC analysis

Experiment-3

6. Design of CMOS NAND gate Schematic and its analysis.

Experiment-4

7. Design of CMOS NOR gate Schematic and its analysis.

Experiment-5

8. Layout design CMOS inverterand its analysis

Experiment-6

9. Layout design CMOS NAND/NOR gate and its analysis.

Experiment-7

10. Design and Implementation of a Half Adder Using CMOS Logic with Schematic Diagram.

Experiment-8

11. Design of 4:1 mux using pass transistor logic.

Experiment-9

12. Design and Analysis of a Common Source Amplifier with Schematic Diagram.

Experiment-10

13. Design and Analysis of a Basic Current Mirror with Schematic Diagram.

Experiment-11

14. Design and Analysis of multistage amplifier.

Experiment-12
15. 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** *The student should be able to*	**Relevant SDG**	**SDG 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 CMOSlogic 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** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
	differential amplifiers using MOS schematic with Cadence EDA tools.			semiconductor technology development.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LABORATORY

Class: B. Tech. V – Semester		**Branch:** ECE	
Course Code:	**U24EC510**	**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 : develop python programs to perform data handling, preprocessing, and visualization using NumPy, Pandas and Matplotlib.

CO2 : implement regression and classification algorithms to build machine learning models and analyze their performance.

CO3 : apply clustering techniques and neural network models for pattern recognition and data analysis.

CO4 : develop neural network programs using activation functions, perceptron, feed forward networks, and back propagation for pattern classification applications.

Experiment-1

2. Develop a program to create and perform operations on NumPy arrays.
3. Develop a program to demonstrate array indexing and slicing.
4. Develop a program to perform mathematical operations on arrays.

Experiment-2

1. Develop a program to create and manipulate Pandas DataFrames.
2. Develop a program to handle missing values using Pandas.
3. Develop a program to split dataset into training and testing sets.

Experiment-3

1. Develop a program to implement simple linear regression.

Experiment-4

1. Develop a program to implement multiple linear regression.
2. Develop a program to implement polynomial regression.

Experiment-5

1. Develop a program to implement logistic regression.
2. Develop a program to implement K-Nearest Neighbors (KNN).

Experiment-6

1. Develop a program to implement Naïve Bayes classifier.
2. Develop a program to implement Decision Tree classifier.

Experiment-7

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, 1st edition, 2016, California.
2. Satish Kumar, *Neural Networks – A Classroom Approach*, McGraw Hill Education, 2nd edition, 2017, India.

Reference Book(s):

1. Jiawei Han, Micheline Kamber, Jian Pei, *Data Mining: Concepts and Techniques*, 3rd 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*, 2nd 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=PLVedk3nRvxDScQQpgMS6PBqV2lEeXJSLj; *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 *The student should be able to…*	Relevant SDG	SDG 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:**	-

Course Learning Outcomes (COs)

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

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

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.

Guidelines:

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%**

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

(h) **Seminar 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.

(i) **Report:** Each student is required to submit a well-documented report on the chosen seminar topic as per the format specified by *DSEC.*

(j) **Anti-Plagiarism Check:** The seminar report should clear the plagiarism check as per the Anti-Plagiarism (including AI Plagiarism) policy of the institute.

(k) **Presentation:** 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.

6th 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 underadditional 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 twosubjects (6-Credits)during 2-months internship at the institute

OR

Successful completion of twosuitable 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. Voc 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	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 forB. Voc in ECE Degree.

Exit Option to Qualify B. Voc in ECE: Any Two (02) Skill based Courses -:									
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**O**	**E**	**C**
1	SEC	U24SE610X	Internet of Things (IOT) using Arduinohttps://www.nitttrchd.ac.in/imee/Labmanuals/manual%20Internet%20of%20Things%20I.pdf	-	-	6	-	6	3
2	SEC	U24SE611X	Embedded System Design using ARM/Cortex Micro Controller https://www.nielit.gov.in/aurangabad/content/certificate-course-embedded-system-design-using-arm-cortex-microcontroller-0	-	-	6	-	6	3
3	SEC	U24SE612X	Embedded System using 8051 and Arduinohttps://www.nielit.gov.in/sites/default/files/PDF/Training/EmbeddedSystemusing8051andArduino.pdf	-	-	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 6th semester covering GATE syllabus).

MANAGEMENT ECONOMICS AND ACCOUNTANCY

Class: B. Tech. VISemester		**Branch:**Common to all	
Course Code:	**U24OE601A**	**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 : 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 andScope 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 ofHuman 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, 11th 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, 7th 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; *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; *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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

ENGINEERINGFINANCE

Class:B.Tech.VI-Semester		**Branch:**Common to all	
Course Code:	**U24OE601B**	**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: explain fundamentals of engineering finance, financial management objectives, ethics, and time value of money concept.

CO2 : apply capital budgeting techniques including inflation adjusted Net Present Value/Internal Rate Return for project evaluation and selection.

CO3: analyse various cost concepts and determine breakeven point for make or buy decisions in engineering projects.

CO4: evaluate asset replacement decisions and apply depreciation methods to determine the economic life and value of engineering assets.

UNIT-I	**9 Hrs**

Fundamentals of Engineering Finance

Engineering Finance – Meaning, Definition, and Scope; Role of Finance in Engineering – Importance for engineers in decision makingand 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

UNIT-II	**9 Hrs**

Investment Decisions

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

UNIT-III	**9 Hrs**

Cost-Volume-Profit Analysis

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

UNIT-IV	**9 Hrs**

Replacement Decisions and Valuation of engineering assets

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.

TextBook(s):

1. M Y Khan and P K Jain, *Financial Management,* Tata McGraw Hill 5th 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 2nd 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. 3rd edition, ISBN: 978-0123869685, 2014.
3. D. N. Dwivedi, *Engineering Economics: Text & Cases*, Vikas Publishing,5thedition, 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.3rd edition, ISBN: 978-9352864379, 2017.
6. Chatterjee Partha Sheikh Salim, *Engineering Economy & Financial Management*, Himalaya Publishing House, ISBN:978-9350247389, 2011.

CourseArticulationMatrix(CAM):								**U24OE601B:ENGINEERINGFINANCE**						
CO		**PO1**	**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	2.3	-	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	Explain fundamentals of engineering finance, financial management objectives, ethics, and time value of money concept.	SDG 4 And 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 And 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 And	Industry, Innovation and	Encourages cost efficiency, optimized production planning,

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant 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 And 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%**

Course Learning Outcomes (COs)

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

CO1 : evaluate the fundamentals, importance, influencing factors, and communication processes of Organizational Behaviour.

CO2 : analyse individual behaviour including personality, perception, learning, attitudes, emotions, stress, and motivation.

CO3 : examine group behaviour, team effectiveness, conflict management, leadership, power, politics, and group dynamics in organizational settings.

CO4 : evaluate organizational structure, culture, innovation, change, organizational effectiveness, quality of work life, and international organizational behaviour.

UNIT-I	**9 Hrs**

Introduction: 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

UNIT-II	**9 Hrs**

Individual Behavior: 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

UNIT-III	**9 Hrs**

Group decision making: 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

Group dynamics: Group dynamics, Leadership-Leadership types and managerial effectiveness, Trust and leadership, Power and politics, Basis of power, Organizational politics

UNIT-IV	**9 Hrs**

Organization structure: 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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

E-COMMERCE & DIGITAL MARKETING

Class: B. Tech. VI – Semester		**Branch:**Common to all	
Course Code:	**U24OE601D**	**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 : interpret the concepts, scope, types, functions, framework, opportunities, and limitations of E-Commerce, and analyse its role in modern business and electronic transactions

CO2 : analyze e-payment systems, e-finance operations, e-banking, e-trading, and the legal framework governing e-commerce transactions

CO3 : evaluate digital marketing practices, emerging trends, and consumer behaviour in the online environment

CO4 : determine digital marketing channels and design effective online marketing plans

UNIT-I	**9 Hrs**

Introduction to E-Commerce: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

UNIT-II	**9 Hrs**

E-payment Systems: 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

Legal Framework for E-Commerce: 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

UNIT-III	**9 Hrs**

Digital Marketing: 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

UNIT-IV	**9 Hrs**

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

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														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Understand theconcepts, scope, types, functions, framework, opportunities, and limitations of E-Commerce, and analyse its role in modern business and electronic transactions.	**SDG 8**	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.	**SDG 9**	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.	**SDG 12**	Responsible Consumption and Production	Digital marketing helps organizations understand consumer behaviour and promote sustainable and responsible consumption patterns.
CO4	Analyzedigital marketing channels and design effective online marketing plans.	**SDG 17**	Partnerships for the Goals	Digital marketing channels improve global communication, collaboration, networking, and partnerships among businesses and stakeholders

DESIGN FOR TESTABILITY

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC602A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1: Explain testing fundamentals and fault simulation techniques.

CO2: Analyze and sequential testing methodologies.

CO3: Design scan-based and BIST-enabled architectures.

CO4: Apply advanced DFT techniques for modern IC systems.

UNIT-I	9 Hrs

BASICS OF TESTING AND FAULT MODELING: 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.

UNIT-II	9 Hrs

TESTING OF COMBINATIONAL AND SEQUENTIAL CIRCUITS: 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.

UNIT-III	9 Hrs

MEMORY TESTING, DELAY FAULTS AND IDDQ TESTING: 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.

UNIT-IV	9 Hrs

BUILT-IN SELF-TEST (BIST) AND ADVANCED DFT TECHNIQUES: 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.

TextBook(s):

1.M. Abramovici, M. A. Breuer and A. D. Friedman, *Digital Systems Testing and Testable Design*, Jaico Publishing House.

2. P. K. Lala, *Digital Circuit Testing and Testability*, Academic Press.

Reference Book(s):

1. Bushnell and Agrawal, *Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits*, Springer.
2. N. K. Jha and S. Gupta, *Testing of Digital Systems*, 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 *The student should be able to…*	Relevant SDG	SDG 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%**

Course Learning Outcomes (COs)

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

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

Fundamentals of Data Communication: 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

Switching and Internetworking: 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

Transport and Application Layer Protocols: 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

Emerging Trends in Computer Networks: 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.

TextBook(s):

1. Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill.
2. Andrew S. Tanenbaum, Computer Networks, Pearson.

Reference Book(s):

1. William Stallings, Data and Computer Communications, Pearson.
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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

BIO MEDICAL SIGNAL PROCESSING

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC602C**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : learn the fundamental concepts of signal processing

CO2 : apply common signal processing techniques for various biomedical signals

CO3 : Understand electromyo signal processing and feature extraction

CO4 : analyzepolyplethismographic, Electrooculogram and Electroretinogram signals

UNIT-I	9 Hrs

Introduction to Biosignals: Electrical activities of the Cell, Action Potential, Nature of Biomedical Signals, Examples of Biosignals, Objectives and difficulties in Biosignal processing and analysis.

Cardiac signal processing: 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)

UNIT-II	9 Hrs

Neural signal processing: 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).

UNIT-III	9 Hrs

Myo-signal processing: 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

UNIT-IV	9 Hrs

Introduction to other biosignals: Blood Pressure and Blood Flow analysis, Photoplethysmogram signal processing and analysis, Electrooculogram and Electroretinogram signal analysis, Magnetoencephalogram, Respiratory Signals.

TextBook(s):

1. KayvanNajarian and Robert Splinter, "Biomedical Signal and Image Processing", Second Edition, CRC Press, 2005. *(Chapters 1,2,3, 8 to 11)*

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", EEE, PHI, 2004.
Web and Video link(s):
ps://onlinecourses.nptel.ac.in/e-learning/preview/noc20_ee41; *NPTEL Video Lecture on Biomedical Signal Processing 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** *The student should be able to…*	**Relevant SDG**	**SDG 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 electromyo 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%**

Course Learning Outcomes (COs)

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

CO1 : Explain the fundamentals of embedded systems, their components, and applications.

CO2 : Apply hardware–software co-design principles to develop embedded applications.

CO3 : Demonstrate real-time operating system concepts through practical implementations.

CO4 : Analyze advanced embedded technologies and their societal impact.

UNIT-I	9 Hrs

Introduction to Embedded Systems: 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

Hardware–Software Co-Design: 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

Real-Time Operating Systems: 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

Advanced Embedded Technologies: 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.

TextBook(s):

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw Hill.
2. Frank Vahid & Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley.

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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : apply deep learning fundamentals and regularization techniques for tuning the performance of the deep learning models

CO2 : build andanalyze deep convolutional neural network models for image recognition

CO3 : apply recurrent and recursive neural network architectures for handling long term dependencies and vanishing gradient problem

CO4 : build deep learning models for computer vision, speech and natural language processing applications

UNIT-I	**9 Hrs**

Introduction: 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

Regularization for Deep learning: 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**

Optimization for Training Deep Models: Pure optimization, challenges in neural network optimization, Basic optimization algorithms, Algorithms with adaptive learning rates

Convolutional Neural Networks: 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**

Transfer Learning: 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 EncoderRepresentations 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 YoshuaBengio and Aaron Courville, *Deep Learning*, 1st edition, MIT Press, 2017*(Chapters 1 ,6 to 12)*
2. Michael Nielsen, *Neural Networks and Deep Learning*, Determination Press, 1st edition, 2013.

Reference Book(s):

1. Deng & Yu, *Deep Learning: Methods and Applications*, 1st edition, Now Publisher, USA, 2013
2. Antonio Gulli, Amita Kapoor, Sujit Pal, *Deep Learning with TensorFlow 2.0 and Keras*, 2nd edition, Mumbai: Packt, 2019
3. Sebastian Raschka, Vahid Mirjalili - *Python Machine Learning*, 2nd edition, Mumbai: Packt, 2019

Web and Video link(s):

ps://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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC602F**	**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 : 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

Sensors and Actuators in IoT Systems: Block diagram of IoT system, role of sensors and actuators in data acquisition and automation.

Interfacing with IoT Platforms: Interfacing sensors and actuators with Arduino/ESP32/ Raspberry Pi, GPIO, ADC, PWM, I2C, SPI, UART protocols.

IoT Applications: Smart home, industrial automation, smart agriculture, healthcare, environmental monitoring.

TextBook(s):

1. Vijay Madisetti, ArshdeepBahga, Internet of Things (A Hands-on Approach), Universities Press, 1st edition, 2015, India.
2. David E. Culler, Jaswinder Pal Singh, Anirban Maitra, Internet of Things: Architectures and Protocols, Morgan Kaufmann (Elsevier), 1st edition, 2019, USA.

Reference Book(s):

1. S. R. Wate, Sensors and Actuators, Pearson Education India, 2nd edition, 2011, Noida.
2. D. Patranabis, Sensors and Transducers, PHI Learning Private Limited, 2nd edition, 2015, New Delhi.
3. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education, 1st edition, 2017, New Delhi.
4. John G. Webster, Measurement, Instrumentation and Sensors Handbook, CRC Press, 2nd edition, 2014, USA.

Web and Video link(s):

1. https://nptel.ac.in/courses/108/106/108106152/
2. https://www.youtube.com/playlist?list=PLzD-VY8bTCbTqRMUu8fHhLzzLz-2iOltb

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 *The student should be able to…*	Relevant SDG	SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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, SDG 11	Industry, Innovation and Infrastructure; 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

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC603**	**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 : 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. Schafer, "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=MUlBDIvm49lnQopu; *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** *The student should be able to…*	**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 used in medical

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC604**	**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 : examine and utilize System Verilog's key features, advanced data types and procedural constructs to model digital systems

CO2 : design and manipulate arrays, queues, and linked lists to build modular and reusable verification environments

CO3 : construct class-based verification components using OOP principles and implement constrained randomization to achieve coverage-driven verification.

CO4 : employ functional coverage strategies and build UVM-based testbench architectures to verify complex digital designs with reusable and scalable methodologies

UNIT-I	9 Hrs

Introduction to System Verilog: 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.

UNIT-II	9 Hrs

Arrays: 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.

UNIT-III	9 Hrs

Basics of OOPs: OOP Terminology, Basic OOP Concepts, Class, Class Declaration & Creation of Object, this Keyword, Creating New Objects, Object Deallocation, Using Objects, Static Variables vs. Global Variables, Class Methods.

Randomization: Introduction, What to Randomize, Randomization in System Verilog, Constraint Details, Equivalence Expressions, Weighted Distributions, Conditional Constraints.

UNIT-IV	9 Hrs

Functional Coverage, Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example

UVM: 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.

TextBook(s):

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; *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** *The student should be able to…*	**Relevant SDG**	**SDG 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 principlesand 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.

ANTENNAS AND WAVE PROPAGATION

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC605**	**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 : discussradiation mechanism & fundamental characteristics of antennas

CO2 : design two element & n-element arrays

CO3 : build UHF, VHF & microwave antennas

CO4 : distinguish ground wave, space wave & sky wave propagation

UNIT-I	**9 Hrs**

Linear Wire Antennas : 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

Antenna Properties: 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

UNIT-II	**9 Hrs**

Linear Antenna Arrays: 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.

Non-Resonant Radiators: Introduction, Travelling wave radiators - Basic concepts, V and Inverted V- antennas, Rhombic antenna- Construction details &design considerations

UNIT-III	**9 Hrs**

VHF, UHF and Microwave Antennas: 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

UNIT-IV	**9 Hrs**

Wave Propagation: 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

TextBook(s):

1. E.C. Jordan and K.G. Balmain, *Electromagnetic Waves and Radiating Systems*, 2nd ed., New Delhi:Prentice Hall of India(PHI), 2001.*(Chapters 10,11,12)*

2. John D Kraus, Ronald J Marhefka and Ahmad Khan. Kraus, *Antennas and Wave Propagation*, 4th ed., New Delhi: Tata McGraw Hill Education, 2011.(*Chapters 2,4 to 9,14,22,23,24,25)*
Reference Book(s): 1. Constantine A.Balanis, *Antenna Theory,* 2nd ed., New York: John Wiley & Sons, 1997. 2. G.S.N.Raju, *Antennas and Wave Propagation*,1st ed., New Delhi:Pearson, 2004. 3. K.D.Prasad, *Antenna and Wave Propagation*, 3rd ed., New Delhi: Satya Prakashan, 1996. 4. F.E.Terman, *Electronic and Radio Engineering*, 4th ed., New York: McGraw-Hill, 1955. 5. R.L.Yadav, *Antennas and Wave Propagation,* 2nd ed., NewDelhi: Prentice Hall of India(PHI),2013
Web and Video link(s): 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** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	discussradiation 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

Class: B. Tech. VI – Semester		**Branch:**Common to all branches	
Course Code:	**U24IK606B**	**Credits:**	**1**
Hours/Week (L-T-P-E):	**2-0-0-2**	**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: describe harmony within the individual by understanding the distinct roles of the self and the body

CO2 : analyze values in human relationships and apply the principles of justice, mutual happiness, and harmony in family and society.

CO3: explain the interconnectedness of nature and existence and evaluate the concept of coexistence and mutual fulfilment among all orders of nature.

CO4: apply professional ethics and sustainable practices in engineering and professional activities for societal and environmental well-being.

UNIT-I	6 Hrs

Course Introduction - Need, Basic guidelines, Content and Process for value education **Self-exploration**: '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

Understanding Harmony in the Human Being: Harmony in myself, Understanding human being, Understanding the harmony of self with the body, Harmony in self; Health; Program for self and health

UNIT-II	6 Hrs

Understanding Harmony in the Family: Harmony in human - human Relationship, Understanding values in human-human relationship, Meaning of Justice (universal values in relationships), Mutual happiness

Understanding Harmony in the Society: Harmony in the society, Visualizing a universal harmonious order in society- Undivided society, Universal order- from family to world family

UNIT-III	6 Hrs

Understanding Harmony in the Nature: 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,

Understanding Harmony in the Existence: Understanding existence as co-existence of mutually interacting units in all- pervasive space; Holistic perception of harmony at all levels of existence.

UNIT-IV	6 Hrs

Professional Ethics: 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,*JeevanVidya:EkParichaya*,Raipur:JeevanVidyaPrakashan, Amarkantak, 2018. 2. A.N.Tripathi,*HumanValues*,NewAge InternationalPublisher,3rded.,NewDelhi, 2019. 3. M.Govindrajran,S.Natrajan&V.S.SenthilKumar,*EngineeringEthics(includesHuman Values)*, PHI Learning Pvt. Ltd., 12thed., Haryana, 2011. 4. Jayshree Suresh, B. S. Raghavan, *Human Values & Professional Ethics*, 4thed., S. Chand & Co. Ltd.,New Delhi, 2012. **AdditionalResources:** 1. AsetofDVDscontaining-VideoofTeachers‟OrientationProgram-PPTsofLectures and Practice Sessions (*Audio-visual material for use in the practice sessions*)
Web and Video link(s): 1. https://fdp-si.aicte-india.org/UHVII.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** *The student should be able to…*	**Relevant 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** *The student should be able to…*	**Relevant 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, SDG 12	Industry, Innovation and Infrastructure; Responsible Consumption and Production	1. Encourages ethical professional practices, sustainable technologies, and environmentally responsible production systems.

DIGITAL SIGNAL PROCESSING AND APPLICATIONS LABORATORY

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC607**	**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 : 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

2. Develop a program to demonstrate power spectrum of a given sequence.
3. Develop a program to design FIR LP filter using windows.
4. Develop a program to design FIR HP filter using windows (rectangular window, triangular window, hamming window &Hanning window).

Experiment-4

2. Developa program to design IIR Lowpass Butterworth Filter.
3. Develop a program to design IIR High Pass Chebyshev Filter.

Experiment-5

2. Developa program to demonstrate autocorrelation of two given sequences.
3. Developa program to demonstrate cross correlation of two given sequences.

4. Developa 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. Ifeachor, Digital Signal Processing-A practical Approach, Pearson Education India, 4/e, 2013. *(Chapter 10)*

Reference Book(s):

1. A. V. Oppenheim & R. W. Schafer, "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):

ps://youtu.be/0ENnxVXEv_U?si=MUlBDIvm49lnQopu; *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** *The student should be able to*	**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** *The student should be able to*	**Relevant SDG**	**SDG 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

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	**U24EC608**	**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 : 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, Assignmodports 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. *Create driver, monitor, sequencer, Generate UART transactions, Measure functional correctness with scoreboard*
Experiment-7
Generate transaction-level stimulus with randomized fields. *Define sequence class with random variables, Apply constraints for valid packets, Observe randomized stimulus in DUT*
Experiment-8
Develop functional coverage for request-grant signals. *Define covergroups and bins, Add cross coverage for request vs grant, Measure coverage percentage after simulation*
Experiment-9
Implement a scoreboard for DUT output checking. *Capture DUT outputs, Compare with expected results, Log mismatches for debugging*
Experiment-10
Apply concurrent assertions in a design example. *Insert assert property constructs, Validate timing and protocol rules, Observe assertion failures in simulation*
Experiment-11
Experiment with build, connect, run, and report phases. *Implement UVM testbench with phases, Track execution order, Measure simulation logs for phase transitions*
Experiment-12
Construct reusable verification components. *Create parameterized driver/monitor classes, Reuse across multiple DUTs, Measure reduction in coding effort*
<u>TextBook(s):</u> 1. Taraate, Vaibbhav, *SystemVerilog for Hardware Description: RTL Design and Verification*. Springer Nature, 2020. *(Chapters 1 to 4)* 2. Salemi Ray, *The UVM primer: An introduction to the universal verification methodology*. Boston Light Press, 2013.*(Chapters 1 to 6, 11 to 13, 17 to 23)*
<u>Reference Book(s):</u> 1. Sutherland, Stuart, Simon Davidmann, and Peter Flake, *SystemVerilog for Design: A guide to using SystemVerilog for hardware design and modelling*. Boston, MA: Springer US, 2006.
<u>Web and Video link(s):</u> tel.ac.in/courses/117103125; *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** *The student should be able to*	**Relevant SDG**	**SDG 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

Class: B. Tech. VI – Semester		**Branch:** ECE	
Course Code:	U24EC610	**Credits:**	**1**
Hours/Week (L-T-P-E):	**0-0-2-1**	**CIE:**	100%
Total Number of Teaching Hours:	**-**	**ESE:**	**-**

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%
DMPEC Assessment: *Oral presentation with PPT and viva-voce*	15%
SDG Alignment	5%
Research Alignment	10%
Total Weightage:	**100%**

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 HoDconcerned
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		1.75	2	1.5	2.25	2.25	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.

3rd Year Exit Courses Syllabus

Bridge Courses for exit:

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

(OR)

Successful completion of twosuitable 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. Voc 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	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 forB. Voc in ECE Degree.

Exit Option to Qualify B. Voc in ECE: Any Two (02) Skill based Courses -:									
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**O**	**E**	**C**
1	SEC	U24SE610X	Internet of Things (IOT) using Arduinohttps://www.nitttrchd.ac.in/imee/Labmanuals/manual%20Internet%20of%20Things%20I.pdf	-	-	6	-	6	3
2	SEC	U24SE611X	Embedded System Design using ARM/Cortex Micro Controller https://www.nielit.gov.in/aurangabad/content/certificate-course-embedded-system-design-using-arm-cortex-microcontroller-0	-	-	6	-	6	3
3	SEC	U24SE612X	Embedded System using 8051 and Arduinohttps://www.nielit.gov.in/sites/default/files/PDF/Training/EmbeddedSystemusing8051andArduino.pdf	-	-	6	-	6	3
4	SEC	U24SE613X	Any other skill-based course approved by BoS Chair and Dean AA	-	-	6	-	6	3

LOW POWER VLSI

Class: B.Tech. VI –Semester (Exit course)		Branch: ECE	
Course Code:	**U24EC610X**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**32Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 :	illustrate the importance of low power design
CO2 :	identify the various source of power consumption inCMOS circuits
CO3 :	develop the techniques to reduce the power dissipation in CMOS circuits
CO4 :	examine the circuit with probabilistic power technique
CO5 :	Design and simulate CMOS circuits to analyze dynamic and static power consumption under different operating conditions.
CO6 :	Estimate power dissipation and switching activity of CMOS circuits using SPICE simulation and probabilistic power analysis techniques.
CO7 :	Implement and evaluate circuit- and logic-level low-power design techniques such as transistor sizing, logic optimization, voltage scaling, and energy recovery.
CO8 :	Design and compare leakage power reduction techniques including power gating, transistor stacking, VTCMOS, MTCMOS, and Dual-Vt CMOS circuits.

THEORY COMPONENT

UNIT-I	**9 Hrs**

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

UNIT-II	**9 Hrs**

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.

UNIT-III	**9 Hrs**

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

UNIT-IV	**9 Hrs**

Leakage Power minimization Approaches: Variable-thresholdvoltage CMOS (VTCMOS) approach multi-threshold-voltage CMOS(MTCMOS) approach Power gating Transistor stacking Dual-Vtassignment approach (DTCMOS)

LABORATORY COMPONENT

List of Experiments

1. Design and simulate a CMOS inverter and measure dynamic and static powerconsumption under different input frequencies.
2. Analyze the effect of supply voltage (VDD) and threshold voltage (Vth) 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.

TextBook(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 & Systemsby 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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B.Tech. VI –Semester (Exit course)		**Branch:** ECE	
Course Code:	**U24EC611X**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**32Hrs**	**ESE:**	**40%**

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	
UNIT-I	**4Hrs**
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	**4Hrs**
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	**4Hrs**
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	**4Hrs**
Beyond 5G and Emerging Technologies: Device-to-Device (D2D) communication, Internet	

of Things (IoT) in 5G, Vehicle-to-Everything (V2X) communication, UAV-assistedcommunication, Edge computing and network slicing, AI/ML in wireless communication,Reconfigurable Intelligent Surfaces (RIS), Introduction to 6G technologies, Securitychallenges 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).

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):		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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B.Tech. VI –Semester (Exit course)		**Branch:**ECE	
Course Code:	**U24EC612X**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**32Hrs**	**ESE:**	**40%**

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

Introduction toOperatingSystems: Operating system concepts, Fundamental and Functions, Evolution of Operating Systems, Operation, Structure and Architecture of Computer Systems, OS Structure and Operations, Kernel Data Structures.

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

Real Time Operating Systems: 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.

UNIT-III	4Hrs
Objects, Services and I/O: Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem.	
UNIT-IV	**4Hrs**
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.	

LABORATORY COMPONENT

List of Lab Experiments:

1. Study and execute basic Linux commands for file and directory operations, permissions, text processing, and archiving.
2. Implement UNIX/Linux System Calls for File Management
3. Implement Process Creation and Management Using System Calls
4. Implement and compare CPU scheduling algorithms such as FCFS, SJF, Priority Scheduling, and Round Robin based on waiting time and turnaround time.
5. Create multiple tasks and implement synchronization using semaphores, mutexes, and message queues in an RTOS environment (FreeRTOS/RTLinux).
6. Develop applications using pipes, signals, shared memory, and message queues for communication between processes.
7. Implement timer-based tasks, interrupt service routines (ISR), and software timers to study real-time event handling.
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.

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://www.youtube.com/watch?v=LvaU7Vokg9E&t=1s

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	U24EC612X2	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 *The student should be able to…*	Relevant SDG	SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

7th 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

SUSTAINABLEWASTEMANAGEMENTANDCIRCULARECONOMY			
Class:B.Tech.VII –Semester			**Branch:**CE
CourseCode:	U24OE701	**Credits:**	3
Hours/Week(L-T-P-E):	2-1-0-3	**CIE:**	60%
TotalNoofTeachingHours:	36Hrs	**ESE:**	40%

CourseLearningOutcomes(COs)

Aftercompletionofthiscourse,thestudentsshouldbeableto,

CO1: appraisetheconceptofwastemanagement

CO2:analyzeactivitiesassociatedwiththemanagementofhazardouswastes

CO3: applytheconceptofcirculareconomyandconductrelevantresearch

CO4: create business models for sustainable development using complex aspects of circulareconomy.

UNIT-I	9Hrs

Waste management: Introduction, context and overview of waste management, waste landscapeinIndia,hierarchyofwastemanagement,sourcesofwasteandwastestreams, challenges and opportunities in waste management.

Strategies for Waste management: 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 responsibilitiesofvarioussectors,supportinginitiativesofpublicandprivatedomains, internationalrecommendationsand mandates.

UNIT-II	9Hrs

ElementsofHazardouswastemanagement: Hazardouswastedefinition,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.

ManagementofdifferentHazardouswaste:

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.

UNIT-III	9Hrs

IntroductiontoCircularEconomy:LinearEconomyanditsemergence,Economicand Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy. **CharacteristicsofCircularEconomy:** Materialrecovery,wastereduction,reducing negativeexternalities,explainingbutterflydiagram,conceptofloops.	
UNIT-IV	**9Hrs**
Circulardesign,innovationandAssessment:Zerowaste-WasteManagementin contextofCircularEconomy,Circulardesign,Researchandinnovation,Life Cycle Assessment (LCA),Circular Business Models **CaseStudiesandLegalpolicyframework**Businessmodels,SolidWasteManagement / Wastewater, Plastics: A case study, EPR: polluters pay principle, Industrial symbiosis/ Eco-parks,Roleof governments andnetworks,Sharing bestpractices,Universalcircular economypolicygoals,IndiaandCEstrategy,ESG	

<u>TextBook(s):</u>

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-UnitedNationsInstituteforTrainingandResearch-2013-*ISBN: 978-92-807-3333-4*
2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition.
3. IntegratedSolidWasteManagement,EngineeringPrinciplesandManagementIssues, TchobanoglousG,TheisenHandVigilSA,McGrawHillEducation,2014,IndianEdition

<u>ReferenceBook(s):</u>

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-UnitedNationsInstituteforTrainingandResearch-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 EconomyAUser'sGuideWalter RStahel Routledge; 1st Edition (24 June 2019)
5. CircularEconomy:(Re)EmergingMovementShaliniGoyalBhallaInvinciblePublisher
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; *NPTEL Course on Integrated Waste Management for a Smart City – 2025 Edition (Circular Business Models, EPR, Industrial Symbiosis,ESG,Zero-WasteStrategies,IndiaCEPolicyFramework)byProf.BrajeshKumar Dubey,IITKharagpur.*

CourseArticulationMatrix (CAM):				**U24OE701: SUSTAINABLEWASTEMANAGEMENTANDCIRCULARECONOMY**									
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–SDGAlignmentMatrix				
CO	**COStatement** Thestudentshouldbeable to…	**Relevant SDG**	**SDG Description**	**MappingJustification**
CO1	appraisetheconcept ofwastemanagement	SDG12	Responsible Consumption andProduction	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,andhazardouswastesectors.
CO2	analyze activities associatedwiththe 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,andnuclearwaste— safeguards human health and environmentalquality,contributingto the development of safe, resilient, and environmentallysustainableurbanandindustrial communities.

CO3	apply the concept of circular economy and conductrelevantresearch	SDG9	Industry, Innovationand Infrastructure	Applyingcirculareconomyprinciples —materialrecovery,wastereduction, LCA, butterfly diagram, and loop strategies — and conducting innovation-driven research fosters sustainable industrial practices that decouple economic growth from resource depletion, supporting resilient andenvironmentallyresponsibleindustrialinfrastructure.
CO4	Createbusiness models forsustainable development using complex aspects of circular economy.	SDG9	Industry, Innovationand 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, sustainableeconomicgrowthalignedwith 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, *Artificial Intelligence for Sustainable Development: Theory, Practice and Future Applications*, Springer Nature, Computational Intelligence, Volume 912, September 2021,New DELHI.
2. Mohammad Dastbaz, Colin Pattinson, Babak Akhgar ,*Green Information TechnologyA Sustainable Approach*, 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 *The student should be able to…*	Relevant SDG	SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : elaborate Cyber Physical Systems and its applications

CO2 : analyze the safety requirements of Cyber Physical Systems and its models

CO3 : analyze the Asynchronous design primitives in Cyber Physical Systems

CO4 : analyze the applications of Cyber Physical Systems and apply the techniques to ensure security in CPS

UNIT-I	9 Hrs

Cyber-Physical System (CPS): 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.

Synchronous Model: 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

Safety requirements: 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.

Asynchronous Model: Asynchronous processes – States, Inputs, Outputs and Internal actions, Executions,Extendedstate machines, Operations on processes, Safety requirements.

UNIT-III	9 Hrs

AsynchronousDesign Primitives: 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*, 2nded.,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):

PTEL: 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** *The student should be able to…*	**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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

SOFTWAREQUALITYASSURANCEANDTESTING

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%

CourseLearningOutcomes(COs)

Aftercompletionofthiscourse,thestudentsshouldbeableto,

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 containmentstrategies

Quality Assurance Process and Quality Engineering: QA activities in software processes, Verificationandvalidationperspectives, Reconciling thetwoviewsqualityengineering,Activities and process quality planning, Goal setting and strategy formation quality assessment andimprovementquality engineeringin software processes

UNIT-II	9 Hrs

SoftwareTestingBackground:Infamoussoftwarecasestudies,Bug,whydobugsoccur, The costofbugs,Softwaretestingfunctionalities, Goodsoftwaretestercharacteristics.

TheRealitiesofSoftwareTesting:Testingaxioms,Softwaretestingterms and definitions, Precision and accuracy, Testing quality assurance

Examining the Specification: Black-boxand white-boxtesting, Static and dynamictesting, Performinga high leve1 reviewof the specification,Low level specificationtest techniques.

TestingtheSoftwarewithBlindersOn:Dynamicblack-boxtesting,Test-to-passandtest-to-fail, Equivalence partitioningdata testing,Statetesting, Other black-box test techniques

UNIT-III	9 Hrs

Testingthe Softwarewith DynamicWhite-BoxTesting: Dynamic white-boxtesting, Dynamic white-boxtestingvs.debugging,Testingthepieces,Datacoverage, Codecoverage

ConfigurationTesting:An overviewof configurationtesting,Approachingthetask, Obtaining the hardware, Identifying hardwarestandards,Configurationtesting otherhardware

CompatibilityTesting:Compatibilitytesting overview, Platformand applicationversions, Standardsandguidelines datasharingcompatibility

UsabilityTesting:Userinterfacetesting,Userinterfacetesting,Guidelines,Intuitivecons

istent, Flexible,Comfortable,Correct,Useful,Accessibilitytesting,Accessibilityfeaturesinsoftware

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, 1st. 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, 2nd ed., SAMS Publications, 2016.
3. M.G.Limaye,*So{twareTestingPrinciples,TechniquesandTools,* TataMcGraw-Hill Educaiion,1st. ed., 2019, New Dehi.

CourseArticulationMatrix(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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

VLSI PHYSICAL DESIGN

Class: B. Tech. VII – Semester		**Branch:** ECE	
Course Code:	**U24EC702A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : interpret physical design optimizations, graph theory and common EDA terminology, partitioning algorithms and framework for multilevel partitioning

CO2 : identify the suitable floor planning algorithms for global and detailed placement

CO3 : examine the routing algorithms to address the modern challenges in detailed routing

CO4 : formulate the timing analysis and performance constraints for placement and routing

UNIT-I	9 Hrs

Introduction to Electronic Design Automation: VLSI design flow, VLSI design styles, layout layers and design rules, physical design optimizations, algorithms and complexity, graph theory terminology and common EDA terminology

Netlist and System Partitioning: Introduction, terminology, optimization goals, partitioning algorithms, a framework for multilevel partitioning, system partitioning onto multiple FPGAs

UNIT-II	9 Hrs

Chip Planning: Introduction to floor planning, optimization goals in floor planning, terminology, floor plan representations, floor planning algorithms, pin assignment, power and ground routing

Global and Detailed Placement: Introduction, optimization objectives, global placement, legalization and detailed placement

UNIT-III	9 Hrs

Global Routing: Introduction, terminology and definitions, optimization goals, representations of routing regions, the global routing flow, single-net routing, full-netlist routing and modern global routing

Detailed Routing: Terminology, horizontal and vertical constraint graphs, channel routing algorithms, switchbox routing, over-the-cell routing algorithms and modern challenges in detailed routing

UNIT-IV	9 Hrs

Specialized Routing: 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; *NPTEL Video Lecture on VLSI Physical Designby 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** *The student should be able to…*	**Relevant SDG**	**SDG 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 optimizationspromotes 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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VII – Semester		**Branch:** ECE	
Course Code:	U24EC702B	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**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** *The student should be able to…*	**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.
sCO2	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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

ADVANCEDSIGNAL 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%**

Course Learning Outcomes (COs)

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

CO1 : design and implement digital filters for efficient sampling rate conversion applications.

CO2 : analyse and implement non-parametric spectral estimation techniques such as Bartlett, Welch, and Blackman–Tukey methods.

CO3 : explain the fundamentals of autocorrelation and its role in parametric power spectrum estimation.

CO4 : apply Levinson-Durbin and Schur algorithms for efficient solution of normal equations in linear prediction analysis.

UNIT-I	**9 Hrs**

Multirate Signal Processing: 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**

Non-Parametric methods of Power Spectral Estimation: 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**

Parametric Methods of Power Spectrum Estimation: 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**

Linear Prediction : 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.

TextBook(s):

1. J.G.Proakis, D.G.Manolokis,*Digital Signal Processing: Principles, Algorithms& Applications*, Pearson, 4th edition, Prentice Hall India.
2. Alan V Oppenheim, Ronald W Schaffer, *Discrete Time signal processing*, Prentice Hall India.
3. Emmanuel C. Ifeacher, Barrie. W. Jervis, *DSP – A Practical Approach*, Pearson, 2nd edition.

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 *The student should be able to…*	Relevant SDG	SDG 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%**

Course Learning Outcomes (COs)

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

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.

CO2 : Explain Embedded Linux architecture, startup sequence, kernel structure, and apply GNU cross-platform toolchains for embedded system development.

CO3 : Analyze bootloader functionality, kernel configuration and building process, and apply Linux porting techniques for embedded hardware platforms.

CO4 : Explain BSP integration, embedded storage architecture, MTD drivers, memory management, and file system optimization techniques in Embedded Linux systems.

UNIT-I	**9 Hrs**

Review of Operating Systems:review of operating systems.

Linux Fundamentals: 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**

Introduction to Embedded Linux: Embedded Linux-Introduction, Advantage, Embedded Linux Distributions, Architecture, Linux kernel architecture, User space, Linux startup sequence, GNU cross platform Tool chain.

Learning About Toolchains: Introducing toolchains,finding a toolchain, building a toolchain using cross tool-NG,Anatomy of a toolchain.{2}

UNIT-III	**9 Hrs**

All About Bootloaders: What does a bootloader do?The boot sequence,Booting with UEFI firmware,moving from bootloader to kernel,introducing device trees,Choosing a bootloader,Barebox.

Configuring and Building the Kernel: What does the kernel do?,Choosing a kernel,Building the kernel,Compiling – Kbuild,Booting the kernel,Porting Linux to a new board.

UNIT-IV	**9 Hrs**

Board Support Package and Embedded Storage: 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. Dhamdhere, '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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : analyze generative AI foundations, including latent space representations, probabilistic modeling, and density estimation techniques for data generation.

CO2 : apply and analyze deep generative models such as VAEs, GANs, and diffusion models for designing and evaluating generative systems.

CO3 : analyze and apply transformer-based large language models, prompt engineering, and retrieval-augmented techniques for advanced text generation tasks.

CO4 : 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**

Generative AI Overview: Data distributions and density estimation, Explicit vs Implicit generative models, Sampling vs inference, Applications: image synthesis, text generation, augmentation, Limitations and challenges

Latent Space & Representation Learning: Generative vs Discriminative modeling paradigms, Latent variables and embeddings, Continuous vs discrete latent spaces, Manifold hypothesis, Interpolation and arithmetic

Probabilistic Generative Modeling: 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**

Variational Autoencoders (VAEs): Architecture and intuition, Reparameterization trick, KL regularization, Loss function, Applications

Generative Adversarial Networks (GANs): Generator–discriminator framework, Minimax objective, Training challenges, DCGAN, Conditional GANs, Applications - image generation

Diffusion Models: Forward and reverse diffusion, Noise prediction models, Sampling strategies, Comparison with VAEs and GANs, High-level Stable Diffusion

UNIT-III	**9 Hrs**

Transformer Architecture: Self-attention and multi-head attention, Positional encoding, Encoder–decoder vs decoder-only, Pretraining objectives (causal, masked LM), Scaling laws

LLMs: GPT-style models, Pretraining and fine-tuning pipeline, Tokenization and embeddings, Emergent capabilities

Prompt Engineering: Zero-shot, few-shot learning, Instruction prompting, Chain-of-thought reasoning, Prompt design strategies

Retrieval-Augmented Generation (RAG): RAG architecture, Embeddings and vector search, Knowledge grounding, Reducing hallucinations

UNIT-IV	9 Hrs

LLM-based Applications: 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)

LLM Adaptation and Deployment: 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

Multimodal Extensions of LLMs: 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

TextBook(s):

1. David Foster, *Generative Deep Learning*, O'Reilly Media, 2nd edition, 2023, California. *(Chapters 1 to 10)*
2. Daniel Jurafsky, James H. Martin, *Speech and Language Processing*, Pearson, 3rd edition, 2023, New Jersey. *(Chapters 1 to 10, 17 to 21)*

Reference Book(s):

1. Lewis Tunstall, Leandro von Werra, Thomas Wolf, *Natural Language Processing with Transformers*, O'Reilly Media, 1st edition, 2022, California.
2. Sebastian Raschka, *Build a Large Language Model (From Scratch)*, Manning Publications, 1st edition, 2024, New York.
3. AurélienGéron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media, 2nd edition, 2019,California.

Web and Video link(s):

https://onlinecourses.swayam2.ac.in/e-learning/preview/imb24_mg116; *NPTEL Video Lectures on Generative AI and Large Language Models by Prof. Naveen Kumar Bhansali, IIM Bangalore.*

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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VII – Semester		**Branch:** ECE	
Course Code:	**U24EC702F**	**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: 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:

Introduction to a New Age of Intelligence", Elsevier Science, 2014

2. Klaus Elk, "Embedded Software Development for the Internet of Things", CreateSpace Independent Publishing Platform, August 2016
3. Charles Bell, "Beginning Sensor Networks with XBee, Raspberry Pi and Arduino", Second Edition, Apress,2020
4. Peter Hoddie, Lizzie Prader, "IoT Development for ESP32 and ESP8266 with JavaScript", Apress,2020

Reference Book(s):

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
2. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2014.S. Sridhar, *Digital Image Processing*, Oxford University Press, 2nd edition, 2016, Noida.
3. Han-Way Huang, "Embedded system Design Using C8051", Cengage Learning2009.

Web and Video link(s):

1. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html
2. https://nptel.ac.in/courses/108102045
3. https://archive.nptel.ac.in/courses/106/105/106105193/
4. https://onlinecourses.nptel.ac.in/noc22_cs53/preview

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** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Give an overviewthe 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** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO4	Apply ESP 32 & ESP 8266S forvarious 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%**

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.

UNIT-I	**9 Hrs**

Introduction toOperatingSystems: Operating system concepts, Fundamental and Functions, Evolution of Operating Systems, Operation, Structure and Architecture of Computer Systems, OS Structure and Operations, Kernel Data Structures.

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	**9 Hrs**

Real Time Operating Systems: 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.

UNIT-III	**9 Hrs**

Objects, Services and I/O: Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem.

UNIT-IV	**9 Hrs**

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.

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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : Explain IoT fundamentals, architectures, embedded platforms, sensors and communication technologies.

CO2 : Analyze IoT networking protocols, wireless communication systems and cloud connectivity platforms

CO3 : Apply IoT hardware and software concepts for real-time sensing, automation and smart applications.

CO4 : Interpret Industrial IoT, Edge AI, security and emerging IoT applications for smart systems and Industry 4.0.

UNIT-I	9 Hrs

Introduction to IoT and Embedded Systems: 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.

UNIT-II	9 Hrs

IoT Communication and Networking: 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, IoTGatewayConceptsandCloudConnectivity.

UNIT-III	9 Hrs

IoT Sensors, Cloud Platforms and Smart Applications: 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 HealthcareandSmartCityApplications.

UNIT-IV	9 Hrs

Industrial IoT, Security and Emerging Technologies: 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.

<u>TextBook(s):</u>

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things – A Hands-on Approach, Universities Press, 2015.
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.
3. Perry Lea, Internet of Things for Architects, Packt Publishing, 2018.

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** *The student should be able to…*	**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

Class: B. Tech. VII – Semester		**Branch:** ECE	
Course Code:	**U24EC705**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : Explainthe fundamentals of image processing, computer vision and transforms on images

CO2 : Identify and apply different filtering techniques in the spatial domain andfrequency 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, 4th 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, 1st edition, 2015, Chennai. 2. B. Chanda, D. Dutta Majunder, *Digital Image Processing and Analysis*, Prentice Hall of India, 2nd edition, 2011, New Delhi. 3. S. Sridhar, *Digital Image Processing*, Oxford University Press, 2nd edition, 2016, Noida. 4. Munesh C. Trivedi, *Digital Image Processing*, Khanna Book Publishing, 1st 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; *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_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** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Understand fundamentals of image processing, computer vision and transforms on image	SDG 4, SDG 9	Quality Education; Industry, Innovation and Infrastructure	The course outcome promotes advanced knowledge and technical skills in image processing and computer vision,enhancing quality engineering education and lifelonglearning. Understanding image processing and computer vision supports innovation in automation, healthcare, surveillance, smart systems, and industrial

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
				applications.
CO2	Identify and apply different filtering techniques in spatial domain, frequency domain to enhance digital images	SDG4, SDG 9	Quality Education; 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, SDG 9	Quality Education; 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, SDG4, & SDG9	Good Health and Well-being Quality Education; 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
Experiment-10
10.RFID-based Smart Attendance or Access Control System using ESP32/Raspberry Pi
Experiment-11
11.IoT-based Industrial Temperature and Gas Monitoring System with Alert Notification
periment-12
12. Mini Project: Development of Real-Time IoT Application for Smart Home, Smart Healthcare, Smart Agriculture, Smart City or Industry 4.0 Application.

TextBook(s):

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things - A Hands-on Approach, Universities Press, 2015, ISBN: 9788173719547.
2. Matt Richardson and Shawn Wallace, Getting Started with RaspberryPi, O'Reilly (SPD), 2014, ISBN: 9789350239759

Reference Book(s):

1. David, Hanes and Salgueiro Gonzalo, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, Pearson 2017.
2. Dirk Slama and Frank Puhlmann, Enterprise IoT: Strategies and Best Practices for Connected Products and Servicesby 2015

Laboratory Manual (for laboratory component):
IoT and Sensor Laboratory, Department of ECE, KITSW

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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VII – Semester		**Branch:** ECE	
Course Code:	U24EC707	**Credits:**	1
Hours/Week (L-T-P-E):	**0-0-2-2**	**CIE:**	**100%**
Total Number of Teaching Hours:	-	**ESE:**	

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:

1. The internships provide exposure to the real-world, get a feel for the work environment and how a professional workplace operates.
2. 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.
3. Students can learn, more importantly, how to apply the KSQs they have acquired during an internship to their future workplaces.
4. Students will also be able to demonstrate functioning engineering knowledge, both new & existing, and identify areas of further development for their future careers.
5. Internships give the student an opportunity to bridge theory and practice
6. Internships also provide students with the soft skills needed at workplace and leadership positions.
7. The internship guidelines are governed by the rules stipulated in the Institute's Internship Policy-2020 document.
8. 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.
9. 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
   a. creating awareness on mandatory 6-8 weeks internship by every student
   b. creating awareness on COs of internships
   c. KSQs the students would acquire doing internships
   d. expected internship outcomes
   e. available internship options, and organizations offering internships
   f. 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
A. **Internship Supervisor's Assessment** *(i) Feedback from the internship supervisor* *- on completion of internship assignment/work (20%)* *(ii) Feedback from the internship supervisor* *- on quality of work in internship assignment/work (10%)* *(iii) Feedback from the internship supervisor* *- internship log book (10%)* *(iv) Feedback from the internship supervisor* *- on attendance, punctuality and work hours (10%)* (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. DIEC Assessment *(i) Internship duration (8 /12 weeks) (6/8 weeks online via NPTEL and 2/4 weeks offline) (10% / 10%)* *(ii) Internship Report (20%)* *(iii) Oral Presentation (with PPT) and viva voce (10%)* *(iv) SDG (5%)* *(v) Research Orientation (5%)*	**50%**
Total Weightage:	**100%**

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 (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:**	

Course Learning Outcomes (COs):
After completion of this course, the students should be able to,

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**)

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**)

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**)

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**)

1. Final Year Major Project work represents the culmination of study towards the B. Tech degree. ***Major project offers an opportunity to integrate the knowledge acquired from various courses and apply it to solve real-world complex engineering problems***. The **student learning assessment process** (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.
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.
3. **Team work:** Major project work is a team work.
   (i) The students of a project team shall work together to achieve a common objective.
   (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.
4. **Two phases:** Major project work shall be carried out in two phases. Nearly 50 - 75% of the proposed work to be completed in 7thsemester as *Phase-I* and the remaining work to be continued and completed in 8thsemester as *Phase-II.*
5. Every student is expected to put approximately**72hoursofwork**intothemajorproject *phase-I* courseoverthe12weeksof7thsemester.
6. **Majorprojectwork*Phase-I*:7thsemester**
   (i) TheHoDshallconstitutethe***department project evaluation committee (DPEC)***with followingcomposition

Departmentprojectevaluationcommittee(DPEC)		
HoD	Chairman	
SeniorFaculty	Convener	
Coordinator(s)	Section-wisecoordinator(s) *Onecoordinatorforeachsection*	
ThreeFacultymembers	Section-wisefacultymembers *Threefacultymembersforeachsectionrepresentingvariousspecializations.(Fivespecializationswillbecoveredincludingthecoordinator'sandConvener's)*	

(ii) Major project allotment to students during last working week of 6thsemester:

(a) **First / Second week of 6thSemester**: The process shall be initiated during the first / second week of 6thsemester by collecting project titles from the department faculty research groups, on offering innovative ideas/solutions for engineering problems.

(b) **MSE-I period of 6th Semester – Notifying project titles**: The finalizedproject titles shall be notified to students during the MSE-I period of 6th semester and student teams shall be allowed to exercise their options on titles that interest them.

(c) **Last working week of 6th 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 6th semester

(d) **6th semester summer break - Literature review**: This 6th semester schedule enables students to complete literature review, preliminary simulations / investigations / experimentation during 6th semester summer break and *start the work from day-one in 7thsemester*

(e) **Registration Presentation - Notifying the tentative dates:** The major projectteams are expected to give registration presentation during second / third week from the commencement of 7th 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 6th semester, the list of implementable project titles offered by the faculty of different research groups of the department

(a) 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.

i. abstract
ii. deliverables / outcomes
iii. knowledge and skills required to complete the project
iv. resources required
v. 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 6th semester, the faculty supervisors to all project teams

(a) The project supervisors shall

i. **define project objectives and expected deliverables**
ii. 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 applythe knowledgeof 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 engineeringproblems 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 knowledgeand 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 contextualknowledge toassess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

(h) *Ethics* – toapply ethicalprinciples andcommit toprofessional 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 understandingof 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 andability 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 increasea 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 cadenceand considered for evaluation during presentations, i.e., number of planned meetings and number attended by students

(b) **Project Log Book:** The activityjournaling inproject logbook isveryimportant 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 shallspecifically 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, whichcan bespecially acquiredby 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 theother hand, documentinga 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 experimentsconducted, 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 presenttheir project in the form of posters, at the time of demonstration of complete porotype / 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 meticulouslyfollowed 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
A. Supervisor Assessment	**20%**
B. DPEC Assessment *(i) Registration Presentation (10%)* *(ii) Progress Presentation-I (20%)* *(iii) Project progress*: Part of working model/ process/software package/system developed (30%)* *(iii) Well-documented Progress Report on Phase-I work (10%)* *(iv) Video pitch on Phase-I (10%)*	**80%**
Total Weightage	**100 %**

* *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 thelessons 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

a. be 3 to 5-minute-long video (no longer than 5 minutes)
b. be concise and to the point, on the problem and proposed solution
c. show project timeline and sample page of log book
d. 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
e. discuss the impact of proposed solution in *ethical, environmental, societal and sustainable development contexts.*
f. emphasize key points about *business idea, potential market for the proposed solution*

(x) It is mandatory for

(a) every student of the team to *appear for oral presentation and viva-voce,* as part of progress presentation -I to qualify for course evaluation

(b) 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

(c) 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 prescribedformat

(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	175	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.

8th 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).

LOW POWER VLSI

Class: B. Tech. VIII – Semester		**Branch:** ECE	
Course Code:	**U24EC801A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : illustrate the importance of low power design

CO2 : identify the various source of power consumption inCMOS circuits

CO3 : develop the techniques to reduce the power dissipation in CMOS circuits

CO4 : examine the circuit with probabilistic power technique

UNIT-I	**9 Hrs**

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

UNIT-II	**9 Hrs**

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.

UNIT-III	**9 Hrs**

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

UNIT-IV	**9 Hrs**

Leakage Power minimization Approaches: Variable-thresholdvoltage CMOS (VTCMOS) approach multi-threshold-voltage CMOS(MTCMOS) approach Power gating Transistor stacking Dual-Vtassignment approach (DTCMOS)

<u>TextBook(s):</u>

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):
3. Bellaouar, Abdellatif, and Mohamed Elmasry, *Low-power digital VLSI design: circuits and systems,* Springer Science & Business Media, 2012.
Web and Video link(s):
ps://nptel.ac.in/courses/106105034; *NPTEL Video Lecture on Low Power VLSI Circuits & Systemsby 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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : Understand fundamentals of FSO communication systems and optical devices.

CO2 : Analyze atmospheric effects and channel impairments in FSO links..

CO3 : Apply modulation and detection techniques for FSO performance analysis

CO4 : Design and evaluate FSO systems for modern wireless communication applications.

UNIT-I	9 Hrs

Introduction to Optical Wireless Communication: 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

FSO Channel Modelling and Propagation Effects: 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

Modulation, Detection and Performance Analysis: 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

FSO System Design and Applications: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.

TextBook(s):

1. Free-Space Optical Communication Systems by Arun K. Majumdar and Jennifer C. Ricklin
2. Optical Wireless Communications by Z. Ghassemlooy, W. Popoola, and S. Rajbhandari

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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : analyze the speech production mechanism and apply appropriate digital models for the representation of speech signals

CO2 : apply and evaluate time-domain techniques for speech signal analysis and pitch estimation

CO3 : analyze and apply LPC and cepstrum techniques for speech processing

CO4 : interpret the performance of speech processing systems in real-world voice-based applications

UNIT-I	9 Hrs

Fundamentals of Digital Speech Processing: 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

Time Domain Models for Speech Processing: 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

Homomorphic Speech Processing: Introduction, homomorphic systems for convolution-properties of the complex cepstrum, computational considerations, the complex cepstrum of speech, pitch detection, the homomorphic vocoder.

Linear predictive coding (LPC) of speech: 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

Digital Speech Processing for man-machine communication by voice: 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.
<u>TextBook(s):</u> 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)*
<u>Reference Book(s):</u> 1. Ben Gold ,Nelson Morgan and Dan Ellis, *Speech and Audio Signal Processing: Processing and Perception of speech and music*, John Wiley & sons, Inc ,2nd edition. 2. Randy Goldberg and lance riek, *A practical handbook of speech coders*, CRC Press LLC, 2000. 3. Soumya sen, Anjan dutta and Niranjan dey, *Audio processing and speech recognition concepts, techniques and research overviews*, springer briefs in applied sciences and technology, computational intelligence.
<u>Web and Video link(s):</u> 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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

EMBEDDED AUTOMOTIVE SYSTEMS

Class: B. Tech. VIII – Semester		**Branch:** ECE	
Course Code:	**U24EC801D**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : Explain the fundamentals and architecture of automotive embedded systems.

CO2 : Analyse automotive sensors, actuators, and communication protocols used in vehicles

CO3 : Apply automotive software architecture and RTOS concepts in embedded automotive systems.

CO4 : Evaluate advanced automotive embedded applications including EVs and ADAS.

UNIT-I	9 Hrs

Introduction to Automotive Embedded Systems: 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.

	9 Hrs

Automotive Sensors, Actuators and Communication Protocols: 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.

UNIT-III	9 Hrs

Automotive Software Architecture: 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.

UNIT-IV	9 Hrs

Advanced Automotive Embedded Applications: 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

TextBook(s):

1. Automotive Embedded Systems Handbook – Nicolas Navet and Francoise Simonot-Lion, CRC Press.
2. Embedded Systems – Raj Kamal, McGraw Hill Education.
3. Automotive Electronics Handbook – McGraw Hill Publications.

Reference Book(s):

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: EMBEDDED AUTOMOTIVE SYSTEMS**										
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** *The student should be able to…*	**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%**

Course Learning Outcomes (COs)

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

CO1 : apply fundamental NLP methods—including morphological parsing, tokenization, edit distance, N-gram modeling, and smoothing—to analyze and model natural language statistically

CO2 : perform syntactic analysis using POS tagging techniques, formal grammars, CFG parsing algorithms, and probabilistic parsing models

CO3 : interpret and model linguistic meaning through semantic analysis, lexical resources, WSD, semantic role labeling, and discourse-level reference resolution

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.

UNIT-I	9 Hrs

Natural Language Processing: 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

N-Grams: Counting words in corpora, Simple unsmoothed N-grams, Training & Test sets, Evaluating N-grams: Perplexity

Smoothing: Laplace Smoothing, Interpolation, Kneser-Ney smoothing, Class-based N-grams

UNIT-II	9 Hrs

Part-of-Speech tagging: Rule-based Part-of-Speech tagging, MHH part-of-speech tagging, Transformation-based tagging, Evaluation and error analysis

Statistical Parsing : 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

Computational semantics: 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,

Word Sense Disambiguation (WSD): Supervised WSD, WSD evaluation, baselines, and ceilings, Minimally supervised WSD: Bootstrapping, Semantic role labeling

Computational discourse: Reference resolution, Reference phenomenon, The Hobb's algorithm for pronominal anaphora resolution, Coreference resolution, Case study: ConceptNet.

UNIT-IV	9 Hrs
Transformer - 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.	
TextBook(s): 1. Lewis Tunstall, Leandro von Werra, Thomas Wolf, *Natural Language Processing with Transformers*, Revised Edition ,O'Reilly Media, 2022.	
Reference Book(s): 1. Steven Bird, Ewan Klein and Edward Loper, *Natural Language Processing with Python*, 1st ed., O'Reilly Media Inc, 2009. 2. Roland R. Hausser, *Foundations of Comptational Linguistics: Human-Computer communication in Natural Language*, 1st ed., MIT Press, 2011. 3. Annamalai Chockalingam, Ankur Patel, Shashank Verma, Tiffany Yeung. *A Beginner's Guide to Large Language Models.* Online link: *https://www.amax.com/content/files/2024/03/llm-ebook-part1-1.pdf*	
Web and Video link(s): https://onlinecourses.nptel.ac.in/noc25_cs22/preview; *NPTEL Video Lecture onDeep 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 *The student should be able to…*	Relevant SDG	SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

CLOUD AND EDGE COMPUTING FOR IoT

Class: B. Tech. VIII – Semester		**Branch:** ECE	
Course Code:	**U24EC801F**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : Explain fundamentals of cloud computing, IoT architecture and virtualization technologies for connected systems.

CO2 : Analyze edge and fog computing architectures, protocols and real-time IoT data processing techniques.

CO3: Apply cloud platforms, containerization and IoT analytics tools for scalable smart applications.

CO4: Interpret security, AI-enabled edge intelligence and industrial IoT applications for smart infrastructure and sustainable systems.

UNIT-I	9 Hrs

Introduction to Cloud Computing and IoT: 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

UNIT-II	9 Hrs

Edge and Fog Computing for IoT: 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.

UNIT-III	9 Hrs

Cloud Platforms and IoT Analytics- 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.

UNIT-IV	9 Hrs

Security, AI and Smart Applications 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.

TextBook(s):

1. Rajkumar Buyya, James Broberg and Andrzej Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2019.
2. Kai Hwang, Geoffrey Fox and Jack Dongarra, Distributed and Cloud Computing, Morgan Kaufmann, 2018.
3. Pethuru Raj and Anupama Raman, The Internet of Things: Enabling Technologies,

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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VIII – Semester		**Branch:** ECE	
Course Code:	**U24EC802A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : Interpret the basics of micro/nano electromechanical systems including their applications and advantages

CO2 : Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA

CO3 : Analyze the key performance aspects of electromechanical transducers including sensors and actuators

CO4 : Comprehend the theoretical foundations of quantum mechanics and Nano systems

UNIT-I	9 Hrs

Overview of MEMS and Microsystems: 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

UNIT-II	9 Hrs

Microsystems fabrication processes: 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.

UNIT-III	9 Hrs

MEMS Sensors: Design of Acoustic wave sensors, Biomedical Sensors and Bio Sensor, Chemical Sensors, Optical Sensors, Pressure Sensors and Thermal Sensors.

Micro Actuators: 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.

UNIT-IV	9 Hrs

Nanosystems, Quantum Mechanics, and Mathematical Models: 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.
TextBook(s): 1. Tai Ran Hsu, MEMS and Microsystems Design and Manufacture ,TataMcraw Hill, 2002. (Chapter 2, 8 and 9) 2. Sergey Edward Lyshevski, MEMS and NEMS: Systems, Devices, and Structures, CRC Press, 2002 (Chapter 1 and 6)
Reference Book(s): 1. Marc Madou, “Fundamentals of Micro fabrication”, CRC press 2. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006 3. Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers,2001 4. Chang Liu, ―Foundations of MEMS‖ , Pearson education India limited, 2006
Web and Video link(s): ps://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee63, *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
U24EC802A		**1**	1.75	1.75	**1**	**1**	-	-	-	-	-	1.25	**2**	**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	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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VIII – Semester		**Branch:** ECE	
Course Code:	**U24EC802B**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

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 BEYOND5GWIRELESS 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 *The student should be able to…*	Relevant SDG	SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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

Class: B. Tech. VIII – Semester		**Branch:** ECE	
Course Code:	**U24EC802C**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

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 signalprocessing 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 Weily, 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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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.

ROBOTICS AND INTELLIGENT SYSTEMS

Class: B. Tech. VIII – Semester		**Branch:** ECE	
Course Code:	**U24EC802D**	**Credits:**	**3**
Hours/Week (L,T,P, E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

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

CO1 : Explain the fundamentals of mobile robots, wheel configurations, locomotion mechanisms and kinematic models of wheeled mobile robots.

CO2 : Analyze robot motion planning techniques, trajectory generation methods and various robot control strategies used in robotic systems.

CO3 : Apply motion planning and navigation algorithms for autonomous robot navigation in structured and unstructured environments.

CO4 : Illustrate localization, mapping and robot vision techniques used in intelligent robotic systems and autonomous applications.

UNIT - I	9 Hrs

Mobile Robots: 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.

UNIT - II	9 Hrs

Robot Motion Control : 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.

UNIT - III	9 Hrs

Motion Planning and Navigation: Basics, Configuration Space, Obstacles, Motion Planning Methods, Roadmap Approaches, Visibility graphs, Voronoi diagram, Cell Decomposition, Trapezoidal Decomposition, Potential Fields, Bug Algorithms, RRT.

UNIT - IV	9 Hrs

Localization, Mapping and Robot Vision: Localization and Mapping: 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.

Robot Vision: 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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : explain the predictive modeling process, data transformations, predictor removal, and binning techniques.

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

CO3 : analyze classification model performance using class predictions, probabilities, equivocal zones, predictor importance, and measurement errors

CO4 : build time series models including stationarity tests, differencing, AR, MA, ARMA, and ARIMA models, and perform forecasting using Python.

UNIT-I	**9 Hrs**

Introduction to Predictive Modeling: 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**

Measuring Performance in Regression Models: 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**

Measuring Performance in Classification Models: Class Predictions, Well-Calibrated Probabilities, Class Probabilities, Equivocal Zones, Evaluating Predicted Classes, and Evaluating Class Probabilities. **Measuring Predictor Importance:** Numeric Outcomes, Categorical Outcomes, and Other Approaches. **Measuring Predictor Error:** Type III Errors, Measurement Error in the Outcome, and Measurement Error in the Predictors.

UNIT-IV	**9 Hrs**

Time Series Analysis and Forecasting with Python: 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.

TextBook(s):

1. Max Kuhn, Kjell Johnson, *Applied Predictive Modeling*, Springer, 1st edition, 2013, New York.
2. Changquan Huang, Alla Petukhina, *Applied Time Series Analysis and Forecasting with*

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** *The student should be able to…*	**Relevant SDG**	**SDG 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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : Explain the fundamentals of industrial IoT, their components, and technologies.

CO2 : Explain sensor and their functionality and their use in industrial IoT.

CO3 : Demonstrate the implementation and deployment challenges in Industrial IoT.

CO4 : Analyse the applications of Internet of things in industries and learn to deploy a task accordingly.

UNIT-I	**9 Hrs**

Introduction to Industrial Internet of Things: 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**

Introduction to Sensor Technology: 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**

Implementation and Deployment Challenges in Industrial IoT: 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**

Internet of Things Applications: Smart Metering, e-Health Body Area Networks, CityAutomation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector.

Industry-Specific Applications: 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 : INDUSTRIAL 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** *The student should be able to…*	**Relevant SDG**	**SDG 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%**

Course Learning Outcomes (COs)

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

CO1 : classify the radar system describe the principle of operation of MTI, Doppler radars

CO2 : select the radar for target tracking, identify pulse compression techniques and understand phased array radar architecture

CO3 : understand the orbital and functional principles of satellite communication systems, interpret and select appropriate technologies for implementation of specified satellite communication systems.

CO4 : 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.

UNIT-I	9 Hrs

Introduction to Radar: Different types of radar systems, radar block diagram, radar equation, detection of signals in noise, receiver noise and SNR, transmitter power, pulse repetition frequency (PREF), beam shapes.
MTI and Pulse Doppler Radar: Introduction to MTI and doppler radar, delay line cancellers, staggered PRFs, digital MTI processing, moving target indicator, limitation to MTI performance, pulse doppler radar.
Radar Clutter: Introduction, surface clutter radar equation, land clutter, sea clutter, weather clutter, detection of targets in clutter

UNIT-II	9 Hrs

Tracking Radar: Tracking with radar, mono-pulse tracking, conical scan and sequential lobing,limitationto tracking accuracy, tracking in range, low angle tracking
Information from Radar Signals: Basic radar measurements, theoretical accuracy of radar measurements,Ambiguity diagram, Pulse compression techniques, target recognition;
Phased Array Radar Architectures: Introduction, antenna-based architectures, bandwidth-basedarchitectures, function-based radars, scalable radar architectures.

UNIT-III	9 Hrs

Satellite Orbits and Trajectories: Definition, basic principles, orbital parameters, injection velocity andsatellite trajectory, types of satellite orbits, orbital perturbations, satellite stabilization, orbital effects onsatellite's performance, eclipses, look angles: azimuth angle, elevation angle.
Satellite Subsystem: Power supply subsystem, attitude and orbit control, tracking, telemetry andcommand subsystem, payload
Earth Station: Types of earth station, architecture, design considerations, satellite tracking

UNIT-IV	9 Hrs
Multiple Access Techniques: Introduction, FDMA, SCPC systems, MCPC systems, TDMA, CDMA,SDMA **Satellite Link Design Fundamentals:**Transmission equation, satellite link parameters, propagation considerations **Communication Satellites:** Introduction, related applications, frequency bands, payloads, satellite vs. terrestrial networks, satellite telephony, satellite television, satellite radio, regional satellite systems,national satellite systems	

TextBook(s):

1. Sklonik Merrill, Introduction to Radar Systems, 3rd ed., New Delhi: Tata McGraw-Hill,2001.
2. Tom Jeffrey, Phased-Array Radar Design: Application of Radar Fundamentals, SciTech Publishing, Inc.2009, ISBN 978-1-891121-69-2.
3. Anil K. Maini, VarshaAgrawal, Satellite Communications, New Delhi: Wiley India Pvt. Ltd., 2015.

Reference Book(s):

1. Nagaraja N. S., Elements of Electronics Navigation, 2nd ed.,NewDelhi:Tata McGraw-Hill, 1996.
2. Sharma K. K.,Radar, Sonar and Navigation Engineering, 2nd ed., New Delhi: S K Kataria& Sons, 2006.
3. Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd ed., New Delhi: Wiley India Pvt.Ltd , 2017.
4. Dennis Roddy, Satellite Communications, 4th ed., New Delhi: McGraw- Hill International edition, 2006.

Web and Video link(s):

https://nptel.ac.in/courses/117105131; *NPTEL Video Satellite Communication, by Prof. Kalyan Kumar Bandyopadhyay, Professor of Electronics and Electrical Communication Engineering department, IIT Kharagpur*

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** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	classify the radar system describe the principle of operation of MTI, Doppler radars	SDG 9	**Industry, Innovation and Infrastructure** – Build resilient infrastructure, promote sustainable industrialization, and foster innovation.	Radar technologies are fundamental to modern transportation, surveillance, weather monitoring, and defense infrastructure. Understanding radar principles supports technological innovation and development of advanced sensing systems.
CO2	select the radar for target tracking, identify pulse compression techniques and understand phased array radar architecture	SDG 9	**Industry, Innovation and Infrastructure** – Develop reliable, sustainable, and resilient infrastructure through technological innovation.	Advanced radar architectures such as phased-array systems improve detection accuracy, tracking capability, and operational efficiency, contributing to innovative infrastructure and intelligent monitoring systems.
CO3	understand the orbital and functional principles of satellite communication systems, interpret and select appropriate technologies for implementation of specified satellite communication systems.	SDG 9	**Industry, Innovation and Infrastructure** – Increase access to information and communication technologies and foster innovation.	Satellite communication enables global connectivity, remote communication services, disaster management, and digital inclusion, thereby strengthening communication infrastructure worldwide.
CO4	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.	SDG 11	**Sustainable Cities and Communities** – Make cities and human settlements inclusive, safe, resilient, and sustainable.	Efficient satellite communication systems support smart-city services, emergency communication networks, disaster response, remote sensing, and sustainable urban and rural 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%**

Course Learning Outcomes (COs):
After completion of this course, the students should be able to,

Upon completion of the major project work, students will be able to…

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)

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)

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)

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)

1. **Major project work shall be continued in 8th semester as major project *phase-II*:** All the major project teams shall take the *phase -I* work forward and complete the remaining work as *Phase-II* in the 8th semester.
2. Final Year Major Project work represents the culmination of study towards the B. Tech degree. **Major project offers an opportunity to integrate the knowledge acquired from various courses and apply it to solve real-world complex engineering problems**. The **student learning assessment process** (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
3. 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.
4. **Team work:** Major project work is a team work
   - (i) The students of a project team shall work together to achieve a common objective.
   - (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 team having knowledge diversity, gender diversity, social and cultural diversity among its members.
5. Every student is expected to put approximately **168 hours of work** into the major projectphase-IIcourse over the 12 weeks of 8th semester.
6. **Major project work *Phase-II*: 8th semester**
   - (i) The convener DPEC shall release complete schedule of *phase-II* CIE during last week of 7th semester (*well in advance before start of 8th semester*), immediately after

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 theidentified real-world problems.

(b) *Problem analysis* -to identify, formulate, reviewresearch literature, andanalyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

(c) *Applying engineering knowledge* - to applythe knowledgeof 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 engineeringproblems 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 knowledgeand 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 contextualknowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

(h) *Ethics* – to applyethical principlesand committo 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 understandingof 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 andability 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 projecttimeline

(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 shallspecifically 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 upcopying things from other sources resulting in a plagiarized document.

(e) The relevant knowledge, skills and qualities (**KSQ**) an engineering graduate should possess, whichcan bespecially acquiredby 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 porotype / 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 8th 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 meticulouslyfollowed 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 8th 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 meticulouslyfollowed 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/softwarepackage/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
A. CIE **(i) SupervisorAssessment(10%)** **(ii) DPECAssessment(50%)** *(a) Progresspresentation-II(10%)* *(b) Finalpresentation(10%)* *(c) Workingmodel/process/software package/system developed(20%)* *(d) Project video pitch(5%)* *(e) Projectpaper(5%)*	**60%**
B. ESE *(i) Well-documentedprojectreport(15%)* *(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 projectreport)* *(ii) OralpresentationwithPPTsand viva-voce(10%)* *(iii) Project poster(5%)* *(DPEC shall evaluate the project poster, as per the rubrics, well before the ESE. At thetimeofESE,the evaluated project poster marks shall be posted in the award list.Students shall appear for Viva-Voce with a project poster)* *(iv) SDG (5%)* *(v) Research Orientation (5%)*	**40%**
TotalWeightage	**100%**

(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 8th 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 wordswhat 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 gatherinformation 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-predatoryconference/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-IIas 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-IIevaluation 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-IIsupplementary 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.