ISO 9001:2015 AICTE-CII: GOLD Category Institute NAAC-'A' Grade Institute (CGPA: 3.21) NIRF-2020 Rank Band: 201-250

KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE

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

काकतीय प्रैद्योगिकी एवं विज्ञान संस्थान, वरंगल - ५०६ ०१५ तेलंगाना, भारत

కాకతీయ సాంకేతిక విజ్ఞాన శాస్త్ర విద్యాలయం, వరంగల్ - ౫౦౬ ౦౧౫ తెలంగాణ, భారతదేశము

Estd-1980 KITSW

*(An Autonomous Institute under Kakatiya University, Warangal)*

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

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# B.TECH. CURRICULUM

## ACADEMIC YEAR: 2026-27

## DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

## Undergraduate Rules and Regulations-2024 (URR24)
## In accordance with the National Education Policy 2020
## w.e.f AY 2026-27

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

**DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING**

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

*(UGC Autonomous Institute Under Kakatiya University, Warangal)*

# B. Tech (EEE) –CURRICULUM(KITSW-URR24)

## SEMESTER-WISE CURRICULUM WITH SCHEME OF INSTRUCTIONS

### Abbreviations

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

### I SEMESTER

**Stream – I**

| Sl. 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 | U24PY102D | Engineering Physics (for EEE) | 2 | 1 | 2 | 5 | 10 | 4 |
| 3 | PCC | U24EE103 | Electrical Measurements & Sensors | 2 | 1 | - | 4 | 7 | 3 |
| 4 | ESC | U24EE104 | Programming for Problem Solving with C | 2 | 1 | 2 | 5 | 10 | 4 |
| 5 | ESC | U24EE105D | Basic Electrical Engineering (for EEE) | 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 | U24VA109 | 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) | | | | | | | | | |

| Pool – I (Physics) | | | Pool – II (Basic Electrical & Electronics Engineering) | | |
|---|---|---|---|---|---|
| Sl. No. | Course Code | Course Title | Sl. No. | Course Code | Course Title |
| 1 | U24PY102A | Engineering Physics ***(for Civil Engineering)*** | 1 | U24EE105A | Basic Electrical and Electronics Engineering ***(for Civil Engineering)*** |
| 2 | U24PY102B | Engineering Physics ***(for ECIE)*** | 2 | U24EE105B | Basic Electrical Engineering ***(Common to ECE and ECI)*** |
| 3 | U24PY102C | Engineering Physics ***(for CSE)*** | 3 | U24EE105C | Basic Electrical Engineering ***(for CSE)*** |
| 4 | U24PY102D | Engineering Physics ***(for EEE)*** | 4 | U24EE105D | Basic Electrical Engineering ***(for EEE)*** |
| 5 | U24PY102E | Engineering Physics ***(for ECE)*** | | | |

# 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 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

| **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 value theorem (Geometrical interpretation), Cauchy's mean value theorem, Taylor's theorem (Generalized mean value theorem), Expansions of functions- Maclaurin's series, Taylor's series, Maxima and Minima-Conditions, Practical problems (rectangle, right circular cylinder, cone)

| **UNIT-II** | **9 Hrs** |
|---|---|

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

| **UNIT-III** | **9 Hrs** |
|---|---|

**Differential equations of first order (DE):** Reorientation of differential equation of first order and first degree (Formation a differential equation, variables separable method, homogeneous equations,Linear equations), Exact differential equations, Equations reducible to exact equations,

**Applications of differential equations of first order:** 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.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Linear differential equations:** Linear differential equations with constant coefficients, 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 $e^{ax}V(x)$), Method of variation of parameters, Linear dependence of solutions

**Applications of linear differential equations**: Simple harmonic motion, Simple pendulum, Oscillations of spring, Oscillatory electrical circuit-LCR circuit, Electro-mechanical analogies.

**Textbook(s):**

1. Grewal, B.S., *Higher Engineering Mathematics*, Khanna Publishers, Delhi, 44th edition, 2017

**Reference Book(s):**

1. Shanti Narayan, Dr. Mittal P.K, *Differential Calculus*, S. Chand & Co., New Delhi, 1st edition, Reprint 2014
2. Kreyszig E, *Advanced Engineering Mathematics*, Inc, U.K, John wiely & sons, 10th edition, 2020
3. S.S. Sastry, *Engineering Mathematics, Vol.II,* Prentice Hall of India, 3rd edition, 2014.

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

1. https://youtu.be/4EYko9rdF7g?si=WUu12 NPTEL Video Lecture on Infinite series by 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** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24MH101.1** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24MH101.2** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **CO3** | **U24MH101.3** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **CO4** | **U24MH101.4** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **U24MH101** | | **2** | **2** | **1** | **1** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# ENGINEERING PHYSICS *(for EEE)*

| | | | |
|---|---|---|---|
| **Class:** B.Tech. I- Semester | | **Branch:** EEE | |
| **Course Code:** | **U24PY102D** | **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 Outcomes (COs):**

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

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

**CO1:** calculate the electric field, electric potential, magnetic field and flux density using fundamental laws of electrostatics and magnetostatics

**CO2:** classify conducting, superconducting, dielectric materials; determine the properties of magnetic and insulating materials

**CO3:** analyze V-I characteristics of semiconductor diodes and suggest their applications in electrical engineering

**CO4:** calculate load voltage and current of diode rectifier and determine resistances of transistor biasing circuits

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

**CO5**: measure diameter of wire and hollow tubes using Vernier callipers and screw gauge

**CO6**: calculate the amplitude & frequency of a signal and plot the hysteresis curve of ferromagnetic material

**CO7**: determine forward voltage and currents from I-V characteristics of semiconductor diodes and solar cell

**CO8**: identify cut-off, saturation and active regions of NPN transistor

| **UNIT-I** | **9 Hrs** |
|---|---|

**Electrostatics and Magnetostatics:** Electric charges, Coulomb's law, Electric field, Electrostatic potential, Computation of electric field and electrostatic potential due to point and line charges; Magnetic field, Magnetic flux density, Biot-Savart's law, Ampere's law, Faraday's law and Lenz's law

**Piezoelectric materials:** Properties, Piezoelectric effect- applications in electrical engineering

| **UNIT-II** | **9 Hrs** |
|---|---|

**Conducting, Superconducting and Dielectric materials**: Conductors- Electrical and mechanical properties, Low resistivity and high resistivity materials; Superconducting materials- Transition temperature, Critical magnetic field, Meissner effect, Isotope effect, Type-I and Type-II superconductors, Applications in electrical engineering; Dielectric materials- Dielectric constant, Polarization, Properties, Classification of dielectric materials, Dielectric breakdown

**Magnetic and Insulating materials:** Permeability, Susceptibility, Dia, Para and Ferro magnetic materials, Hysteresis, Soft and hard magnetic materials; Insulating materials- Electrical, Mechanical, Thermal and chemical properties, Classification of insulating materials based on operating temperature

| **UNIT-III** | **9 Hrs** |
|---|---|

**Semiconductor Physics:** Classification of solids based on energy band theory- Conductors, Semiconductors and Insulators, Intrinsic semiconductor- Carrier generation and recombination, Intrinsic conductivity; Extrinsic semiconductors- n-type and p-type (qualitative), Extrinsic conductivity, Variation of Fermi energy level with temperature and impurity concentration, Drift and diffusion currents; Hall effect (qualitative)

**Semiconductor diodes:** Formation of a PN junction, Forward and reverse bias, PN junction diode, Diode current equation and its V-I characteristics, Zener diode, Zener diode as voltage regulator, Light emitting diode (LED) and Photodiode (qualitative), Examples of applications of semiconductor diodes

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Rectifiers:** Types of rectifiers- Half-wave rectifier, Full-wave rectifier, Ripple factor, Filters-L, C, LC(L-section) and CLC($\pi$ - section)

**Bipolar Junction Transistors (BJTs):** Transistor structure, Representation of NPN and PNP transistors, Transistor action, Transistor configurations- Common base(CB), Common emitter(CE) and Common collector(CC), Corresponding $\alpha$, $\beta$, $\gamma$ parameters and their relations

**List of Experiments**

1. Linear Measurements using Vernier callipers and screw gauge
2. Determination of wavelength of He-Ne laser using reflection and transmission diffraction grating
3. Determination of dielectric constant of materials using parallel plate capacitor
4. Magnetic hysteresis- B-H curve tracing using CRO
5. Measurement of amplitude and frequency using CRO
6. Study of V-I characteristics of PN junction diode, LED and photodiode
7. Study of V-I characteristics of Zener diode- breakdown voltage
8. Study of I-V characteristics of Solar cell
9. Study of common emitter characteristics of NPN transistor
10. Determination of energy band gap of given semiconductor material
11. Determination of Hall coefficient, carrier density of given semiconducting material using Hall effect setup
12. Numerical aperture and acceptance angle of an optical fiber

**Textbook(s):**

1. M. Avadhanulu and Kshirsagar, TVS Arun Murthy, *A Text Book of Engineering Physics,* S. Chand & Company Ltd, 11th Edn., 2018
2. S Salivahanan, N Suresh Kumar, *Electronic devices and circuits,* Mc Graw Hill Edn., 2017 K.B.Raina, S.K.Bhattacharya, T. Joneja, *Electrical Engineering Materials and Electronic Components*, S.K.Kataria & Sons Publisher, 2005

**Reference Book(s):**

1. Bhattacharya and Bhaskaran, *Engineering Physics*, Oxford University Press, 1st Edn., 2013
2. V. Rajendran, *EngineeringPhysics*, Mc Graw Hill, 2013
3. R.K. Gaur and S.L.Gupta, *Engineering Physics*, Dhanpath Rai and Sons publications, 2013
4. David Halliday, Robert Resnick & S Krane, *Physics Volume I&II*, Wiley India Limited, 5th Edn., 2014

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

1. https://onlinecourses.nptel.ac.in/noc24_ph28/preview; NPTEL *video lecture on Concepts 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 by Prof. M. R. Shenoy, IIT Delhi*
4. https://onlinecourses.nptel.ac.in/noc24_ee143/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 Edn.,2017

| Course Articulation Matrix (CAM): | | U24PY102D- ENGINEERING PHYSICS (*for EEE)* | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO 11** | **PSO1** | **PSO2** |
| **CO1** | **U24PY102D.1** | 2 | 1 | 1 | - | - | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24PY102D.2** | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO3** | **U24PY102D.3** | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO4** | **U24PY102D.4** | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO5** | **U24PY102D.5** | 2 | 1 | 1 | - | 1 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 |
| **CO6** | **U24PY102D.6** | 2 | 1 | - | - | 1 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 |
| **CO7** | **U24PY102D.7** | 2 | 1 | - | - | 1 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 |
| **CO8** | **U24PY102D.8** | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| **U24PY102D** | | **2** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1.5** | **1** | **1** | **1.5** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# ELECTRICAL MEASUREMENTS AND SENSORS

| | | | |
|---|---|---|---|
| **Class:** B.Tech. I - Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE103** | **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 Outcomes (COs):**

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

**CO1**: calculate error in MI & PMMC instruments for measuring of voltage and current in AC & DC circuits

**CO2**: calculate active power, reactive power, energy and power factor using wattmeter, energy meter and power factor meter

**CO3**: determine the R, L & C parameters of a given element using DC and AC bridges

**CO4**: calculate the unknown frequency & phase angle using Lissajous patterns and design simple circuits to integrate sensors for measurement of current, voltage & speed.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Error Analysis:** Significance of Measurement, Static characteristics of measuring system- Linearity, Sensitivity, Precision, Accuracy, Errors in measuring instruments

**Voltage and Current Measuring Instruments:** Introduction and types of analog instruments, Construction, operation, Sensitivity, Errors, Advantages and disadvantages of Permanent Magnet Moving Coil (PMMC) instrument, Moving iron (MI) instruments, Extension of ranges of voltmeters and ammeter, Loading effect on measuring instruments

| **UNIT-II** | **9 Hrs** |
|---|---|

**Measurement of Power, Energy and Power factor:** Construction, Operation, Errors, advantages and disadvantages of Dynamo meter type wattmeter, Induction type energy meter, Measurement of three phase active and reactive power, Phantom loading, Operation of Digital energy meter and power factor meter

| **UNIT-III** | **9 Hrs** |
|---|---|

**DC Bridges:** Measurement of unknown resistance using Wheatstone bridge, Kelvin's double bridge, Megohm Bridge and Megger

**AC Bridges:** Measurement of unknown inductance using Maxwell's bridge, Anderson's bridge, Hay's bridge, Owen's bridge, Measurement of unknown capacitance using DeSauty's bridge, Schering bridge and Wien 's bridge, Q-meter

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Electronic Instruments**- CRO: Construction and operation of Cathode Ray Oscilloscope (CRO) and Digital Storage Oscilloscope (DSO), Measurement of amplitude and frequency using CRO, DSO: Block diagram of DSO, Measurement of signal parameters using DSO, Frequency and phase angle measurement using Lissajous patterns

**Sensors:** ACS712: Hall effect based linear current sensor, 170640: Voltage sensor, LM393: Speed sensor.

**Textbook(s):**


1. A. K. Sawhney, *Electrical and Electronics Measurement and Instrumentation*, Dhanpat Rai Publications, 12th edition, 2001.


**Reference Book(s):**


1. J. B. Gupta, *A course in Electrical and Electronic Measurements and Instrumentation*, Kataria and Sons, 13th edition, 2009.
2. J.G. Joshi, *Electronics Measurements & Instrumentation,* Khanna Publishing House, 2021.
3. Alfred D. Helthic & Willem D.Cooper, *Modern Electronics Instrumentation Techniques*, Pearson/ Prentice Hall of India, 1st edition , 2007.
4. https://www.alldatasheet.es/datasheet-pdf/pdf/174116/ALLEGRO/ACS712.html
5. https://www.datasheethub.com/0-to-25v-dc-voltage-sensor-module/
6. https://ampere-electronics.com/product/lm393-infrared-speed-sensor-encoder-odule/


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

1. https://archive.nptel.ac.in/courses/108/105/108105153/; *NPTEL Video Lectures on Electrical Measurements and Electronics Instruments.*
2. https://archive.nptel.ac.in/courses/106/105/106105193/; *NPTEL Video Lectures on output devices, sensors and actuators.*

| **Course Articulation Matrix (CAM):** | | **U24EE103-ELECTRICAL MEASUREMENTS & SENSORS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE103.1** | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO2** | **U24EE103.2** | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO3** | **U24EE103.3** | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO4** | **U24EE103.4** | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 |
| **U24EE103** | | **3** | **2.5** | **2** | **1** | **1.25** | **1** | **1** | **1** | **1** | **1** | **1** | **3** | **2** |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW | | | | | | | | | | | | | | |

# PROGRAMMING FOR PROBLEM SOLVING WITH C

| | | | |
|---|---|---|---|
| **Class:** B.Tech. I -Semester | | **Branch:** Common to all branches | |
| **Course Code:** | **U24CS104** | **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 Outcomes (COs):**

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

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

**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

| **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

| **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.

| **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)

| **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:** Understanding pointers, 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 a file, Closing a file, Input and output operations on sequential text files.

**Textbook(s):**

1. Balagurusamy.E, *Programming in ANSI C*, McGraw Hill, 8th edition, 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 edition, 2022
2. Brian W. Kernighan and Dennis Ritchie, *The C Programming Language*, Pearson Education India, 2nd edition, 2015
3. Reema Thareja, *Programming in C,* Oxford University Press, 3rd edition, 2023
4. Yashavant Kanetkar, *Let Us C,* BPB Publications, 19th edition, 2022
5. A.K.Sharma, *Computer Fundamentals and Programming in C,* Universities Press, 2nd edition, 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):**

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

| **Course Articulation Matrix (CAM):** | | **U24CS104: PROGRAMMING FOR PROBLEM SOLVING WITH C** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24CS104.1** | 2 | 1 | 1 | 1 | - | - | 1 | - | 1 | - | 2 | 1 | 2 |
| **CO2** | **U24CS104.2** | 2 | 2 | 2 | 1 | - | - | 1 | - | 1 | - | 2 | 2 | 2 |
| **CO3** | **U24CS104.3** | 2 | 2 | 3 | 1 | - | - | 1 | - | 1 | - | 2 | 2 | 2 |
| **CO4** | **U24CS104.4** | 2 | 2 | 3 | 2 | - | - | 1 | - | 1 | - | 2 | 2 | 2 |
| **CO5** | **U24CS104.5** | 1 | 1 | 1 | 1 | 1 | - | 1 | 1 | 1 | - | 2 | 1 | 2 |
| **CO6** | **U24CS104.6** | 1 | 2 | 2 | 2 | 1 | - | 1 | 1 | 1 | - | 2 | 2 | 2 |
| **CO7** | **U24CS104.7** | 1 | 2 | 3 | 2 | 1 | - | 1 | 1 | 1 | - | 2 | 2 | 2 |
| **CO8** | **U24CS104.8** | 1 | 2 | 3 | 2 | 1 | - | 1 | 1 | 1 | - | 2 | 2 | 2 |
| **U24CS104** | | **1.5** | **1.75** | **2.25** | **1.5** | **1** | **-** | **1** | **1** | **1** | **-** | **2** | **1.75** | **2** |

# BASIC ELECTRICAL ENGINEERING

| | | | |
|---|---|---|---|
| **Class:** B.Tech. I -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE105D** | **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 Outcomes (COs):**

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

*(based on cognitive skills acquired from 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 AC circuits and bandwidth & quality factor of series & parallel resonant circuits

**CO4**: determine line & phase quantities in 3- Ø AC circuits and construct incidence, tie-set & cut-set matrices of a given electrical network

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

**CO5**: validate electrical circuits using mesh and nodal analysis

**CO6**: validate network theorems

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

**CO8**: determine line & phase quantities for balanced 3- Ø Star and Delta connection

| **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.**

| **UNIT-II** | **9 Hrs** |
|---|---|

**DC network theorems (Independent sources only): S**uperposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem & Millman's theorem.

| **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.

**Resonance:** Series Resonance, Parallel Resonance, Resonant frequency, Half power frequencies, Quality factor, Bandwidth & Selectivity.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**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.

**Network Topology:** Topological description of networks - lumped vs distributed circuits, Network graph, Tree, Co-tree, Incidence matrix, Fundamental tie-set matrices, and Fundamental cut-set matrices.

**List of Experiments**

1. Verification of Kirchoff's laws
2. Verification of voltage divider rule and current divider rule
3. Verification of Mesh and 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. Frequency response of series RLC circuit
11. Voltage and current relationships between line & phase quantities for balanced 3-phase star & delta connections
12. Interfacing Sensors with Arduino using TINKER CAD -LED blinking

**Textbook(s):**

1. K. Uma Rao, *Basic Electrical Engineering*, Pearson Education, Revised edition ,2016. (Unit-I, II & III)
2. A. Sudhakar, Shyammohan S. Palli – *Circuits and networks*, McGraw-Hill Education, 2015, 5th Edition. (Unit-IV)

**Reference Book(s):**

1. B.L.Thereja, A.K.Thereja, *Electrical Technology Vol. I & II* , S.Chand & Company Ltd, Edition, 2005
2. Edward Hughes, Electrical *& Electronics Technology* , Pearson Education, 10th Edition., 2010.
3. D. P. Kothari and I. J. Nagrath, Basic *Electrical Engineering* , Tata McGraw Hill, Edition, 2010.
4. Chakravarthy A, Sudhipanath and Chandan Kumar, Basic *Electrical Engineering*, Tata McGraw Hill Ltd, Edition, 2009.

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

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 Articulation Matrix (CAM):** | | **U24EE105D: BASIC ELECTRICAL ENGINEERING** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE105D.1** | 2 | 1 | - | - | - | - | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **CO2** | **U24EE105D.2** | 2 | 2 | - | - | - | - | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **CO3** | **U24EE105D.3** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **CO4** | **U24EE105D.4** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **CO5** | **U24EE105D.5** | 2 | 1 | - | - | - | - | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **CO6** | **U24EE105D.6** | 2 | 2 | - | - | - | - | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **CO7** | **U24EE105D.7** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **CO8** | **U24EE105D.8** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **1** | 2 | 1 |
| **U24EE105D** | | **2.5** | **2.25** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **2** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# ENVIRONMENTAL STUDIES

| | | | |
|---|---|---|---|
| **Class:** B.Tech. I Semester | | **Branch:** Common to CE, EEE, ECIE, ECE & CSE | |
| **Course Code:** | **U24CY106** | **Credits:** | **0** |
| **Hours/Week (L-T-P-O-E):** | **2-0-0-3-5** | **CIE:** | **60%** |
| **Total Number of Teaching Hours:** | **24 Hrs** | **ESE:** | **40%** |

**Course Learning Outcomes (COs):**

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

**CO1:** identify the natural resources and practice their usage more equitably

**CO2:** develop an action plan for sustainable alternatives and conserving 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** | **6 Hrs** |
|---|---|

**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

| **UNIT-II** | **6 Hrs** |
|---|---|

**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

| **UNIT-III** | **6 Hrs** |
|---|---|

**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

| **UNIT-IV** | **6 Hrs** |
|---|---|

**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

**Textbook(s):**

**1.** Erach Bharucha, *Text Book of Environmental Studies for Under Graduate Courses,* 2nd Edn., Universities Press (India) Pvt. Ltd, 2013

**Reference Book(s):**

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

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

https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/video lecture on renewable energy resources by Prof. Vaibhav. V. Goud and Dr. R. Anandalakshmi, Dept. Of Chemical Engineering, Guwahati.

| **Course Articulation Matrix (CAM):** | | **U24CY106 ENVIRONMENTAL STUDIES** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO 9** | **PO 10** | **PO 11** | **PSO 1** | **PSO2** |
| **CO1** | **U24CY106.1** | 2 | 1 | 2 | 1 | - | 2 | 1 | 1 | 1 | - | - | 1 | 1 |
| **CO2** | **U24CY106.2** | - | - | 2 | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 1 |
| **CO3** | **U24CY106.3** | 1 | 2 | 1 | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | **U24CY106.4** | - | - | 1 | - | - | 1 | 1 | 1 | 1 | - | 1 | 1 | 1 |
| **U24CY106** | | **1.5** | **1.5** | **1.5** | **1** | **-** | **1.25** | **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 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

| 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.<br>• 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, 2nd Edition 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 Articulation Matrix (CAM):** | | **U24AE107 - IDEA Lab Makerspace** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **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 | | | | | | | | | | | | | | |

## II SEMESTER

**Stream-I**

| Sl. No. | Category | Course Code | Course Title | Lectures / week | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | C |
| 1 | BSC | U24MH201 | Matrix Theory and Vector Calculus | 2 | 1 | - | 3 |
| 2 | BSC | U24CY202D | Engineering Chemistry (for EEE) | 2 | 1 | - | 3 |
| 3 | PCC | U24EE203 | Analog Electronics | 2 | 1 | - | 3 |
| 4 | ESC | U24EE204 | Data Structures through C | 2 | 1 | - | 3 |
| 5 | HSMC | U24MH205 | English Communication and Report Writing | 2 | - | - | 2 |
| 6 | VAC | U24VA206 | Sports & Yoga | - | - | 2 | - |
| 7 | ESC | U24ME207 | Engineering Graphics Through CAD | - | - | 2 | 1 |
| 8 | SEC | U24EE208 | Programming Skill Development (PSD) Lab-1 | - | - | 2 | 1 |
| 9 | ELC | U24CY209D | Engineering Chemistry Lab (for EEE) | - | - | 2 | 1 |
| 10 | ESC | U24EE210 | Data Structures through C Lab | - | - | 2 | 1 |
| | | | Total: | 10 | 4 | 10 | 18 |

| Pool – III (Chemistry) | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1. | U24CY202A | Engineering Chemistry *(for Civil Engineering)* |
| 2. | U24CY202B | Engineering Chemistry *(for ECIE)* |
| 3. | U24CY202C | Engineering Chemistry *(for CSE)* |
| 4. | U24CY202D | Engineering Chemistry *(for EEE)* |
| 5. | U24CY202E | Engineering Chemistry *(for ECE)* |

**Bridge Courses for exit:**

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

**(OR)**

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

**A. After First Year: (UG Certificate in EEE)**

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

| Exit Option to Qualify UG Certificate in EEE: Any Two (02) Courses during the 2 - Months internship | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S. No. | Category | Course Code | Course Title | L | T | P | O | E | C |
| 1 | PCC | U24EE211X | Electrical Wiring | 2 | - | 2 | - | 4 | 3 |
| 2 | PCC | U24EE212X | Fundamentals of Electrical Wire joints and Soldering | 2 | - | 2 | - | 4 | 3 |
| 3 | PCC | U24EE213X | Lighting installation | 2 | - | 2 | - | 4 | 3 |
| 4 | PCC | U24EE214X | Any other course approved by BoS Chair and Dean AA | 2 | - | 2 | - | 4 | 3 |

**(OR)**

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

| **Exit Option to Qualify UG Certificate in EEE: Any Two (02) Skill-based Courses -:** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S. No. | Category | Course Code | Course Title | L | T | P | O | E | C |
| 1 | SEC | U24SE211X | Electrical Household Wiring | - | - | 6 | - | 6 | 3 |
| 2 | SEC | U24SE212X | Electrical Earthing Installation | - | - | 6 | - | 6 | 3 |
| 3 | SEC | U24SE213X | Electrical illumination and testing | - | - | 6 | - | 6 | 3 |
| 4 | SEC | U24SE214X | Any other skill-based course approved by BoS Chair and Dean AA | - | - | 6 | - | 6 | 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 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

| **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, 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

| **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)

| **UNIT-III** | **9 Hrs** |
|---|---|

**Vector Calculus and its applications:** - Vector Space, Linear dependent and independent vectors, 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, Decomposition of vector valued functions

| **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

**Textbook(s):**


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


**Reference Book(s):**


1. Spiegel M, *Vector Analysis* -Schaum's Series, McGraw Hill, 2nd edition, 2017
2. S.S. Sastry, *Engineering Mathematics, Vol.II,* Prentice Hall of India, 3rd edition, 2014.
3. Gilbert Strang, *Introduction to Linear Algebra*, Wellesley-Cambridge Press, 5th edition


**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 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO 1 | U24MH201.1 | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO 2 | U24MH201.2 | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO 3 | U24MH201.3 | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| CO 4 | U24MH201.4 | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| U24MH201 | | **2** | **2** | **1** | **1** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **1** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# ENGINEERING CHEMISTRY (*for EEE*)

| | | | |
|---|---|---|---|
| **Class:** B.Tech. II-Semester | | **Branch:** EEE | |
| **Course Code:** | **U24CY202D** | **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 Outcomes (COs)**

*After completion of this course, the students should be able to,*
*(based on cognitive skills acquired from theory component)*

**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**: perceive solution for industrial pollution and suggest the suitability of chemical fuels for electrical applications
**CO4**: summarize the synthesis of nanomaterials and polymers
*(based on psychomotor skills acquired from laboratory component)*
**CO5**: estimate hydroxide ion and alkalinity of water sample
**CO6**: determine total hardness and oxygen dissolved in water
**CO7**: calculate molarities of acids and bases
**CO8**: prepare nano materials and polymers

| **UNIT-I** | **9 Hrs** |
|---|---|

**Electrochemical Energy Systems:** Specific conductance, Equivalent conductance, The effect of dilution; Conductometric titrations, Electrode potential, Nernst equation, Potentiometric titrations

**Batteries**:Introduction, Classification of batteries, Components, Construction, Working principles, Chemical equation and application of zinc carbon, Lead acid, Lithium-ion, Ni -Cd batteries, and Fuel cells

| **UNIT-II** | **9 Hrs** |
|---|---|

**Water Technology: C**haracteristics of natural water**,** Hardness of water, Estimation of hardness of water by Complexometry, Alkalinity, Determination of alkalinity, Determination of fluoride, Effect of fluoride, Water treatment by Filtration, Aeration, Electro dialysis, De-mineralization

**Corrosion and its Control:** Introduction, Dry corrosion, Wet corrosion, Pilling- Bedworth rule, Effect of purity, Relative areas of anodic and cathodic parts, Nature of surface film, Humidity, $p^H$ and Temperature on corrosion, Cathodic protection-Impressed current cathodic protection, Sacrificial anodic protection; Electroplating, Galvanization

| **UNIT-III** | **9 Hrs** |
|---|---|

**Industrial Pollution and its Control**: Industrial pollution and wastewater from various industries, Environmental pollution due to thermal & nuclear power plants and its control and solid waste disposal

**Chemical fuels**: Introduction, Definition and classification of chemical fuels, Primary and secondary fuels, Solid, Liquid and gaseous fuels, Requirements of good fuel, Calorific value, Solid fuels, Coal and its ranking, Liquid fuels, Fractionation of petroleum, Composition and uses of gasoline, Diesel and kerosene, Cracking & its significance

| **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 and graphene's-brief explanation, Properties and applications, Biosensors

**Polymers:** Introduction–polymer, Monomer condensation, Thermo-setting and

thermoplastic resins, Bakelite-applications, PVC-applications

**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)

**Text Book(s):**

1. Jain and Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Company, 17th Edn., 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, 3rd Edn., 2003
3. S. S. Dara, S. S. Umare, *A Text book of Engineering Chemistry*, S. Chand & Company Ltd., 12th Edn.,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*

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

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

| **Course Articulation Matrix (CAM):** | | **U24CY202D ENGINEERING CHEMISTRY (*for EEE*)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24CY202D.1** | 2 | - | - | - | 1 | 1 | 1 | - | 1 | - | 1 | 1 | 1 |
| **CO2** | **U24CY202D.2** | 2 | - | - | - | 1 | 1 | 1 | - | 1 | - | 1 | 1 | 1 |
| **CO3** | **U24CY202D.3** | 2 | 1 | 1 | - | - | 1 | 1 | - | 1 | - | 1 | 1 | 1 |
| **CO4** | **U24CY202D.4** | 2 | - | - | - | 1 | 1 | 1 | - | 1 | - | 1 | 1 | 1 |
| **CO5** | **U24CY202D.5** | 2 | 1 | - | - | - | 1 | 1 | - | 1 | - | 1 | - | - |
| **CO6** | **U24CY202D.6** | 2 | 1 | - | - | 2 | 1 | 1 | - | 1 | - | 1 | - | - |
| **CO7** | **U24CY202D.7** | 2 | 1 | - | - | - | 1 | 1 | - | 1 | - | 1 | - | - |
| **CO8** | **U24CY202D.8** | 2 | 1 | - | - | - | 1 | 1 | - | 1 | - | 1 | - | - |
| **U24CY202D** | | **2.00** | **1.00** | **1.00** | **-** | **1.25** | **1.00** | **1.00** | **-** | **1.00** | **-** | **1.00** | **1** | **1** |

# ANALOG ELECTRONICS

| | | | |
|---|---|---|---|
| **Class:** B.Tech. II -Semester | **Branch:** Common to ECI and EEE | | |
| **Course Code:** | **U24CI203** | **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 Outcomes (COs):**

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

**CO1**: design biasing circuits for BJT amplifier and apply h-parameters to determine the gain & impedance of BJT amplifiers

**CO2**: analyze the frequency response of RC coupled amplifier and volt-ampere characteristics of JFET &MOSFET

**CO3**: determine the gain and impedance of the feedback amplifier by identifying its topology

**CO4**: estimate the frequency of oscillations of given oscillator and efficiency of a large signal amplifier

| **UNIT-I** | **9 Hrs** |
|---|---|

**Bipolar Junction Transistor (BJT) Biasing:** Bias stability - Need for biasing , Operating point, Thermal runaway; Stability factor (S), Methods of BJT biasing - Fixed bias, Collector to base bias, Self bias

**Small Signal Low Frequency Transistor Amplifier Circuits:** BJT small signal low frequency h-parameter model, Analysis of transistor amplifier circuits using h-parameters, Analysis of single stage CE transistor amplifier circuits, Hybrid- Л(pi) Common emitter transistor model

***Self Learning Topics (SLTs): E****mitter feedback bias (Text1: topics6.12.2), Simplified CE and CC h-parameter model (Ref1: topics 12.4 , 12.5), Solved problems (Text1: Examples 6.30, 6.37,6.41), Solved problems (Text1:Examples 9.3, Prob 9.4)*

| **UNIT-II** | **9 Hrs** |
|---|---|

**Multistage Amplifiers :** Different coupling schemes used in cascading of amplifiers, Choice of transistor configurations in cascading, Effect of cascading on gain and bandwidth, Frequency response of RC coupled amplifier, Emitter follower, Darlington connection

**Junction Field Effect Transistor (JFET) :** Construction and operation, Characteristic parameters of JFETs, Drain & transfer characteristics, FET as a switch, Analysis of single stage FET amplifier, Metal Oxide Semiconductor Field Effect Transistor(MOSFET)-structure and operation of Enhancement MOSFET and Depletion MOSFET

Self Learning ***Topics (SLTs):*** *General analysis of cascade amplifier(Text1:topics10.3), cascode amplifier (Text1: topics 10.3,10.9), solved problem(Text1:Example10.1)*

| **UNIT-III** | **9 Hrs** |
|---|---|

**Feedback Amplifiers:** Basic concept of feedback, Negative feedback amplifiers - Characteristics, Effect of negative feedback, Topologies; Analysis of voltage series, Voltage shunt, Current series and Current shunt feedback amplifiers

***Self Learning Topics (SLTs):*** *effect of feedback on input and output impedances (Text1:topics14.6.14.7), Solved problems (Text1: Prob 14.7, Prob 14.10,14.13)*

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Oscillators:** Conditions for oscillations (Barkhausen criterion), RC and LC oscillators, Crystal Oscillator

**Large Signal Amplifiers**: Classification based on biasing, Series fed and transformer coupled Class A amplifier, Class B power amplifier, Push-pull and complementary symmetry Class B amplifiers, Cross over distortion, Class-AB power amplifier

***Self Learning Topics (SLTs):*** *classification of oscillators (Text1:topics 15.2),Second and higher order harmonic distortion(Text1: topics 12.4,12.5), Thermal stability and heat sinks (Text1: topics 12.9)*

**Textbook(s):**


1. S. Salivahana and N.Suresh Kumar, *Electronic Devices and Circuits*, McGraw Hill Education , New Delhi, 3rd edition, 2015


**Reference Book(s):**


1. Jacob Millman and C.C.Halkias, *Integrated Electronics*, Tata McGraw-Hill, New Delhi, 2nd edition, 1991
2. Robert L.Boylestad, Louis Nashelsky, *Electronic Devices and Circuit Theory*, Pearson education, New Delhi, 10th edition, 2013

3. Donald A Neamen, *Electronic Circuits Analysis and Design*, Tata McGraw-Hill, New Delhi, 3rd edition, 2009

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

1. https://www.youtube.com/watch?v=PSdHf6yozyc; *NPTEL Video Lecture on Transistor Biasing by Prof. T.S.Natarajan, Department of physics, IIT Madras*
2. https://www.youtube.com/watch?v=BSR26SU3R2U; *NPTEL Video Lecture on RC coupled amplifiers –frequency response by Prof. D.C. Dube, Department of Physics, IIT Delhi*
3. https://www.youtube.com/watch?v=xHNDrbB-iWY; *NPTEL Video Lecture on positive feedback and oscillations by Dr.Chitralekha Mahanta, Department of Electronics and Communication Engineering, IIT Guwahati*
4. https://www.youtube.com/watch?v=4m49vM0Ryt8; *NPTEL Video Lecture on Field Effect Transistors Prof. T.S.Natarajan, Department of physics, IIT Madras*

**Course Articulation Matrix (CAM): U24CI203 ANALOG ELECTRONICS**

| CO | | PO1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **U24CI203.1** | 2 | 2 | - | - | - | - | 1 | - | 1 | - | 1 | 1 | - |
| **CO2** | **U24CI203.2** | 2 | 2 | - | - | - | - | 1 | - | 1 | - | 1 | 1 | - |
| **CO3** | **U24CI203.3** | 2 | 2 | - | - | - | - | 1 | - | 1 | - | 1 | 1 | - |
| **CO4** | **U24CI203.4** | 2 | 2 | - | - | - | - | 1 | - | 1 | - | 1 | 1 | - |
| **U24CI203** | | **2** | **2** | **-** | **-** | **-** | **-** | **1** | **-** | **1** | **-** | **1** | **1** | **-** |

# DATA STRUCTURES THROUGH C

| | | | |
|---|---|---|---|
| **Class:** B.Tech. II –Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE204** | **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 Outcomes (COs):**

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

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

**CO1:** analyze 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

| **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,Prob 2,Prob 3,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, Singly linked 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), Skiplist (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)*

**Textbook(s):**

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

**Reference Book(s):**

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

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

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 through C Laboratory Manual and Record Book,* Department of EEE , KITSW.

| **Course Articulation Matrix (CAM):** | | **U24EE204 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** | **PSO1** | **PSO 2** |
| **CO1** | **U24EE204.1** | 2 | 2 | 2 | 1 | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24EE204.2** | 2 | 2 | 2 | 2 | - | - | 1 | - | 1 | - | 2 | 2 | 2 |
| **CO3** | **U24EE204.3** | 2 | 2 | 2 | 2 | - | - | 1 | - | 1 | - | 2 | 2 | 2 |
| **CO4** | **U24EE204.4** | 2 | 2 | 2 | 2 | - | - | 1 | - | 1 | - | 2 | 2 | 2 |
| **U24EE204** | | **2** | **2** | **2** | **1.75** | **-** | **-** | **1** | **-** | **1** | **-** | **1.75** | **2** | **1.75** |

# ENGLISH COMMUNICATION AND REPORT WRITING

| | | | |
|---|---|---|---|
| **Class:** B.Tech. II –Semester | | **Branch:** Common to all branches | |
| **Course Code:** | **U24MH205** | **Credits:** | **2** |
| **Hours/Week (L-T-P-O-E):** | **2-0-0-3-5** | **CIE:** | **60 %** |
| **Total Number of Teaching Hours:** | **36 Hrs** | **ESE:** | **40 %** |

**Course Learning Outcomes (COs):**

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

**CO1**: apply basic grammar principles in speech and writing, read fast, form new words, make coherent paragraphs and adapt the real value of life.

**CO2**: create effective letters, e-mails, reply to Memos and do the given tasks with confidence.

**CO3**: analyze the given texts and write clear and unambiguous reports.

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

| **UNIT-I** | **9Hrs** |
|---|---|

**GRAMMAR**

- Tenses-Structures-usage-examples-exercises for practice
- Sentence Correction-Correct use of Tenses, Verb forms, Punctuation.

**VOCABULARY**

- Word formation: Prefixes-Suffixes-Sentence Formation with newly formed words

**READING SKILL**

- Definition-Sub skills of Reading-Emphasis on Skimming-Purpose- How to skim through the text-Examples, Exercises for practice

**WRITING PRACTICES**

- Paragraph Writing- Definition-Organizing Principles of paragraphs -Making a paragraph through hints/graphs and pictures-Coherence-Linking Devices-Systematic Development of Ideas
- Paraphrasing-Précising lengthy expressions for clarity and brevity

**LIFE SKILLS**: Ethical Values and Humanity The Last Leaf: A Short Story by O. Henry

| **UNIT-II** | **9 Hrs** |
|---|---|

**GRAMMAR**

- Tenses-Revision-Exercises for practice
- Subject-Verb Agreement
- Reported Speech-Transformation
- Sentence Correction -Emphasis Concord ,Report Speech, Sentence Structures

**VOCABULARY**

- Synonyms-Antonyms-Single Word Substitutes-Popular Abbreviations

**READING STRATEGY**

- Emphasis on Scanning the Text-Purpose-Advantages-Examples, Exercises and Practice through Teamwork
- **WRITING PRACTICES**
- Letter Writing- Effective Letter Writing Techniques-Information Seeking Letters-Job Application Letters-Apology Letters-Explanation to Memos- E-mails-Cover Letters-Resume

**LIFE SKILLS**: Determination

- How I Became a Public Speaker: An essay by George Bernard Shaw ***Self Learning Topics (SLTs):*** *English Vocabulary (Text 2,Unit-I,Unit-II,Unit-III),Tenses (Reference book 3,Topic-30, Exercises,30.1,30.2,30.3*

| **UNIT-III** | **9 Hrs** |
|---|---|

**GRAMMAR**

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

**VOCABULARY**

- Phrasal Verbs-Technical Words-Latin Words

**READING STRATEGY**

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

**WRITING PRACTICES**

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

**LIFE SKILLS**: Positive Attitude

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

| **UNIT-IV** | **9 Hrs** |
|---|---|

**GRAMMAR**

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

**VOCABULARY**

- Appropriate Use of Words in Communication-Commonly Confused Words

**ACTIVE READING and NOTE-MAKING**

- Note-Making-Definition-Purpose-Effectiveness

**WRITING PRACTICES**

- Précis Writing- Definition-Purpose-Uses-Examples and Exercises-Practice through Teamwork
- Preparing Statement of Purpose (SoP)

**LIFE SKILLS:** Emotional Balance A Poison Tree: Poem by William Blake

**Textbook(s):**

1. Sanjay Kumar & Pushp Lata, " *English Language and Communication Skills for Engineers"* As per the latest AICTE syllabus, Oxford University Press, 1st edition 2018
2. *"Language and Life: A Skill's Approach"* Based on the latest AICTE model curriculum Orient Blackswan Private Limited 2nd Edition 2019.

**Reference Book(s):**

1. Thomson A.J. , Martinet A.V., "*A Practical English Grammar*", Oxford University Press 3rd Edition 1997
2. Thomson A.J. ,.Martinet A.V, "*A Practical English Grammar*" Exercise 2 , Oxford University Press 3rd Edition 1997
3. Standard Allen W. , "*Living English Structure*", Pearson India Education Pvt Ltd. 5th Edition 2009

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

1. https://onlinecourses.nptel.ac.in/noc20_hs56/preview Technical English for Engineers by Aisha Icbal, IIT Madars
2. https://onlinecourses.swayam2.ac.in/cec21_lg13/preview Indian Writing in English by Dr.Bindu Ann Philip, St Mary's College Trissur

| **Course Articulation Matrix (CAM):** | | **U24MH105/205: ENGLISH COMMUNICATION & REPORT WRITING** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24MH105.1** | - | - | - | - | - | 1 | - | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO2** | **U24MH105.2** | - | - | - | - | - | 1 | - | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO3** | **U24MH105.3** | - | - | - | - | - | 1 | - | 2 | 2 | 2 | 2 | 1 | 1 |
| **CO4** | **U24MH105.4** | - | - | - | - | - | 1 | - | 2 | 2 | 2 | 2 | 1 | 1 |
| **U24MH105/205** | | **-** | **-** | **-** | **-** | **-** | **1** | | **2** | **2** | **2** | **2** | **1** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# SPORTS /YOGA

| | | | |
|---|---|---|---|
| **Class:** B.Tech : II-Semester | | **Branch : All UG 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:** | **130 Hrs (13 weeks X10 hours)** | **ESE :** | **40%** |

**Course Learning Objectives (LOs):** This course Sports/Yoga will enable students to:
LO1: know about Yoga and its Benefits
LO2: develop skills and techniques of various Sports &Games.
LO3: inculcate Sportsman spirit.
LO4: all round development of the students to meet the requirements of the society.

## Sports and Games

**List of Sports and Games**

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

**Textbook(s):**


1. Badminton for Schools – Author -Jake Downey, Publisher - S.Chand & Company Ltd., Ram Nagar, New Delhi-110055. Length : 159 Pages.
2. Basketball Skills & Rules – Author – O.P.Sharma, Publisher – Khel Sahitya Kendra, 4264/3, Ansari Road, Darya Ganj, New Delhi-110002, Length : 166 pages.
3. Title. How to Reassess Your Chess: Chess Mastery Through Chess Imbalances. Author:Jeremy Silman, Edition, 4, illustrated, reprint, Publisher : Silman-James Press, 2010, ISBN.1890085138, 9781890085131, Length : 658 pages, Subject :Games & Activities ,General.
4. Football Skills & Rules – O.P.Sharma, Publisher – Khel Sahitya Kendra, 4264/3, Ansari Road, Darya Ganj, New Delhi-110002, Length : 215 pages.
5. Teaching & Coaching Table Tennis – Author – Deepak Jain, Publisher – Khel Sahitya Kendra, WP-474, Ist Floor, Shiv Market, Ashok Vihar, Delhi-1100052, Length : 196 pages.
6. Volleyball for Schools, Author – Dave James, Publisher - S.Chand & Company Ltd., Ram Nagar, New Delhi-110055. Length : 125 Pages.
7. Yoga Education, Author – Dr.Tarak Nath Pramanik, Publisher – India's First Publisher & Asia's No.1 Stockist of Physical Education & Sports Books, 7/26, Ground Floor, Ansari Road, Daryaganj, New Delhi-110002, Length : 347 pages.
8. Indian Cricket ,1999 compiled by G.VISWANATH,53rd Edition,Pblished by Kasturi &Sons Limited, Chennai-600002, Length : 784 pages.
9. Health And Fitness, Author – Dr.A.K.Srivastava, Sports Publication, 7/26, Ground Floor, Ansari Road, Darya Ganj, New Delhi-110002, Length : 72 pages.
10. Modern Kabaddi, AuthorE .Prasad Rao, Published by D.V.S New Delhi-110019.


**Reference Book(s):**


1. Rules and Skills of Games and Sports, Author – B.K.Chaturvedi, Publisher – Goodwill Publishing House, B-9, Rattan Jyoti, 18 Rajendra Place, New Delhi – 110008 (India)
2. Dare To Be A Champion.Lee Chong Wei (Brand), Genres**Biography**
3. 199 pages, Paperback,First published July 1, 2012
4. This edition,Format,199 pages, Paperback,Published,January 1, 2012 by Bukuganda Digital & Publication,ISBN,9789671084328,ASIN,967108432X,Language,English.
5. ***The Book of Basketball: The NBA According to the Sports Guy*** is the second book by former ESPN columnist Bill Simmons.[1] Published in 2009, it covers the history of the National Basketball Association (NBA). In 2019, Simmons launched a sequel podcast series, **Book of Basketball 2.0**, which analyzes the evolution of the league since the book was published.
6. Title. How to Reassess Your Chess: Chess Mastery Through Chess Imbalances. Author:Jeremy Silman, Edition, 4, illustrated, reprint, Publisher : Silman-James Press, 2010, ISBN.1890085138, 9781890085131, Length : 658 pages, Subject :Games & Activities ,General.

7. The Stars of Football: The World's Best Players Kindle Edition by Rodolphe Gaudin (Author) Format: Kindle Edition, Games & Activities / Chess, Games & Activities / General
8. The Complete Volleyball Handbook Kindle Edition, by Bob Bertucci (Author), Makoto Katsumoto (Author), Yasumi Nakanishi (Author), Toshiaki Yoshida (Author) Format : Kindle Edition. 4.5.4.5 out of 5 stars 15 ratings.
9. Cricket skills& Rules, Author.V.Thani,khel sahitya Kendra ,4264/3,Ansari Road,Darya Ganj,New Delhi-110002. Length : 202 pages
10. Health Exercise And Fitness, Author – J.P.Muller, Sports Publication, WP-474, 1st Floor, Shiv Market, Ashok Vihar, Delhi -110052, Length : 117 Pages.
11. Yogic Science, Author – Dr.T.Thangamani, Dr.T.Godwin Vedanayagam Rajkumar, Publisher - Physical Education & Sports Books, 7/26, Ground Floor, Ansari Road, Daryaganj, New Delhi-110002, Length : 274 pages.

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

Badminton game Video Link :
https://www.youtube.com/watch?v=HucIqi8Lw3E&t=22s
Basket Ball game Video Link :
https://www.youtube.com/watch?v=-tkE2lJoR58
Chess Video Link :
https://www.youtube.com/watch?v=mDw7lgM8ePo
Carrom game Video Link :
https://www.youtube.com/watch?v=z8vvJpNceeg
Football game Video Link :
https://www.youtube.com/watch?v=mXjW78AgGu4
Table Tennis game Video Link :
https://www.youtube.com/watch?v=bLrJGWvWI4U
Volleyball game Video Link :
https://www.youtube.com/watch?v=BJJb3-O0Q1U
Cricket game Video Link :
https://www.youtube.com/watch?v=87hO_Vs3-wQ
Handball game Video Link :
https://www.youtube.com/watch?v=VCa_0USaq8k
Kabaddi game Video Link :
https://www.youtube.com/watch?v=ai1m7ARNyNI
Kho-Kho game Video Link :
https://www.youtube.com/watch?v=P3_z3LKdLdg
Yoga Aasanas Video Link :
https://www.youtube.com/watch?v=e0Q88DUOXjk
https://www.youtube.com/watch?v=JoDKbXEUrvQ

ESE-40.

| | | Grade-P (50%) | Grade-D (60%) | Grade-C (70%) | Grade-B (80%) | Grade-A (90%) | Grade-S (100%) |
|---|---|---|---|---|---|---|---|
| 50 mts / 30 mts (Sprint) | Women | 11sec above | 10-11 sec | 9-10 sec | 8-9 sec | 7-8 sec | 7 sec below |
| | | 5 | 6 | 7 | 8 | 9 | 10 |
| | Men | 11sec above | 10-11 sec | 9-10 sec | 8-9 sec | 7-8 sec | 7 sec below |
| | | 5 | 6 | 7 | 8 | 9 | 10 |
| Jump (Standing Broad Jump) | Women | 0.90 – 1 mts | 1.00 – 1.25 mts | 1.25 – 1.50 mts | 1.5 – 1.75 mts | 1.75 – 2 mts | 2 mts above |
| | | 5 | 6 | 7 | 8 | 9 | 10 |
| | Men | 1.50 – 1.7 mts | 1.7 – 1.9 mts | 1.90 – 2.1 mts | 2.30 – 2.1 mts | 2.5 – 2.7 mts | 2.70 mts above |
| | | 5 | 6 | 7 | 8 | 9 | 10 |
| Throw (Shot-put) | Women | 3.5-4.0mts | 4.0-4.5mts | 4.5.5.0mts | 5.0-5.5mts | 5.5-6.0mts | 6.0-6.5mts |
| | | 5 | 6 | 7 | 8 | 9 | 10 |
| | Men | 4.0-5.0mts | 5.0-6.0mts | 6.0-7.0mts | 7.0-8.0mts | 8.0-9.0mts | 9mts above |
| | | 5 | 6 | 7 | 8 | 9 | 10 |
| Yoga Aasanas (Surya Namaskaras) | Women | 2 repetition (12min) | 3 repetition (18min) | 4 repetition (24min) | 5 repetition (30min) | 6 repetition (36min) | 7 repetition (42min) |
| | | 5 | 6 | 7 | 8 | 9 | 10 |
| | Men | 2 repetition (12min) | 3 repetition (18min) | 4 repetition (24min) | 5 repetition (30min) | 6 repetition (36min) | 7 repetition (42min) |
| | | 5 | 6 | 7 | 8 | 9 | 10 |

.CIE-60.

| | | Grade-P | Grade-D | Grade-C | Grade-B | Grade-A | Grade-S |
|---|---|---|---|---|---|---|---|
| | Attendance % | 40-50% | 50-60% | 60-70% | 70-80% | 80-90% | 90-100% |
| | Marks | 10 | 12 | 14 | 16 | 18 | 20 |
| | Performance in Regular Participation in classes : 15 | | | | | | |
| | Performance in Selected Event : 25 | | | | | | |
| | | | | | | | |

**SPORTS AND YOGA FOR ALL UG BRANCHES-U24VA206**

| COs | POs/PSOs | Justification for mapping (Students will be able to) | Level of mapping |
|---|---|---|---|
| CO1:demonstrate physical fitness by performing Yoga-Asanas | PO12 | Performing Yoga Aasanas and make it habituated as a life long process, so that one can improve concentration levels through better mind-body co-ordination. | 1 |
| CO2: Demonstrate physical fitness through various games & sports events with defined benchmarks. | PO9 | Engage in games and sports regularly thus promotes individual and team work. | 1 |
| CO3: demonstrate sportsman spirit and ethics. | PO8 | Exhibit Sportsman Spirit and learn ethics through various games & sports to be a worthy citizen. | 2 |

| | | | |
|---|---|---|---|
| CO4: demonstrate Physical, Psychological, Social and Emotional balance. | PO10 | Exhibit proper balance during emotions sportsman can communicate effectively with peers and can demonstrate physical, psychological, social skills effectively. | 1 |
| | PO12 | Maintain physical, psychological, Social and emotional balance and make it as a lifelong process through Games and Sports. | 1 |

P010.Maintaining physical, psychological, Social and emotional balance is a lifelong process which can be habituated through Games and Sports and enhances communication skills.

| **Course Articulation Matrix (CAM):** | | **U24VA206 Sports / Yoga for all UG Branches** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** | **U24VA206.1** | - | - | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO2** | **U24VA206.2** | - | - | - | - | - | - | - | 1 | - | - | - | - | - |
| **CO3** | **U24VA206.3** | - | - | - | - | - | - | 2 | - | - | - | - | - | - |
| **CO4** | **U24VA206.4** | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - |
| **Average** | | - | - | - | - | - | - | 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:** | **36 Hrs** | **ESE :** | **-** |

**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

**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 centre 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 Duff J.M, *Fundamentals of Engineering Drawing*, Prentice-Hall of India, 1995.


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

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

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

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

**Course Articulation Matrix (CAM): U24ME 207** ENGINEERING GRAPHICS THROUGH CAD

| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | U24ME107/207.1 | 2 | 1 | 1 | - | 2 | - | 1 | - | 2 | - | 1 | 1 | 1 |
| CO2 | U24ME107/207.2 | 2 | 1 | 1 | - | 2 | - | 1 | - | 2 | - | 1 | 1 | 1 |
| CO3 | U24ME107/207.3 | 2 | 1 | 1 | - | 2 | - | 1 | - | 2 | - | 1 | 1 | 1 |
| CO4 | U24ME107/207.4 | 2 | 1 | 1 | - | 2 | - | 1 | - | 2 | - | 1 | 1 | 1 |
| **U24ME107/207** | | **2** | **1** | **1** | **-** | **2** | **-** | **1** | | **2** | **-** | **1** | **1** | **1** |

3 – HIGH, 2 – MEDIUM, 1 - LOW

# ENGINEERING CHEMISTRY LABORATORY (*for EEE*)

| | | | |
|---|---|---|---|
| **Class:** B.Tech. II-Semester | | **Branch:** EEE | |
| **Course Code:** | **U24CY209D** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **CIE:** | **40%** |
| **Total Number of Teaching Hours:** | **36 Hrs** | **ESE:** | **60%** |

**Course Learning Outcomes (COs)**

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

**CO1**: estimate hydroxide ion and alkalinity of water sample

**CO2**: determine total hardness and oxygen dissolved in water

**CO3**: calculate molarities of acids and bases

**CO4**: prepare nano materials and polymers

**LIST OF EXPERIMENTS**

13. Estimation of hydroxide ion [$OH^-$] by acidimetry using standard sodium carbonate solution
14. Estimation of alkalinity of water sample containing (i) carbonate; (ii) carbonate & bi carbonate in ground water
15. Estimation of alkalinity of water sample containing (i) bicarbonate; (ii) carbonate & hydroxide in potable water
16. Determination of hardness of water by complexometric method
17. Determination of dissolved oxygen in a sample of water
18. Standardization of sodium hydroxide (NaOH) by conductometry using standard hydrochloric acid (HCl)
19. Standardization of acetic acid ($CH_3COOH$) by conductometry using standard sodium hydroxide (NaOH)
20. Standardization of strong acid hydrochloric acid (HCl) by potentiometry using standard sodium hydroxide (NaOH)
21. Colorimetric analysis-verification of Lambert-Beer's law
22. Estimation of ferrous ($Fe^{2+}$) ion in the given solution using potassium permanganate
23. Preparation of nanoparticles of cadmium sulphide (CdS)
24. Synthesis of polymer (phenol-formaldehyde)

**Textbook(s):**


2. Mendham, J., Denney, R.C., Barnes, J.D. and Thomas, M.J.K., *Vogel's Textbook of Quantitative Chemical Analysis*, Pearson Education, 6th edition, 2009.
3. Sivasankar, B., *Engineering Chemistry*, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2nd edition, 2013.


**Reference Book(s):**


1. J.C. Kuriacose and J. Rajaram, *Chemistry in Engineering and Technology* (vol. I), Tata Mc. Graw-Hills Education Pvt. Ltd., 2010
2. Sharma, B.K., *Instrumental Methods of Chemical Analysis*, Goel Publishing House, Meerut, 24th Edition, 2005.


**Laboratory Manual:**


2. *Engineering Chemistry Laboratory Manual for EEE,* Department of PS, KITSW


| **Course Articulation Matrix (CAM):** | | **U24CY209D ENGINEERING CHEMISTRY (*for EEE*)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | U24CY209D.1 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | - | 1 | - | - |
| **CO2** | U24CY209D.2 | 2 | 1 | - | - | 2 | 1 | 1 | - | 1 | - | 1 | - | - |
| **CO3** | U24CY209D.3 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | - | 1 | - | - |
| **CO4** | U24CY209D.4 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | - | 1 | - | - |
| **U24CY209D** | | **2** | **1** | | | **2** | **1** | **1** | | **1** | | **1** | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | estimate hydroxide ion and alkalinity of water sample | SDG 6 | Clean Water and Sanitation | Supports assessment and monitoring of water quality for safe and sustainable water resources. |
| CO2 | determine total hardness and oxygen dissolved in water | SDG 6 | Clean Water and Sanitation | Supports assessment and monitoring of water quality for safe and sustainable water resources. |
| CO3 | calculate molarities of acids and bases | SDG3 | Good Health and Well-being | Molarity calculations are essential in preparing chemical and pharmaceutical solutions with correct concentrations. This supports laboratory safety, medical applications, and the prevention of health hazards caused by improper chemical handling. |
| CO4 | prepare nano materials and polymers | SDG 9 | Industry, Innovation and Infrastructure | Promotes development of advanced materials that contribute to technological innovation and sustainable industrial applications. |

# DATA STRUCTURE THROUGH C LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. II – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE210** | **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 and test basic data structures and array operations, including dynamic memory allocation to evaluate their performance and complexity

**CO2 :** apply the linear data structures such as stacks and queues and perform various operations using LIFO or FIFO order respectively

**CO3:** solve problems using various linked list representations for efficiently storing and retrieving the data

**CO4:** 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

## LIST OF EXPERIMENTS

**Experiment-1**

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-2**

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-3**

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

**Experiment-4**

10. Program to implement stack operations
11. Program to convert infix expression into postfix

**Experiment-5**

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-6**

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-7**

19. Program to create single linked list and implement its operations

**Experiment-8**

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

| |
|---|
| 21. Program to create double linked list and implement its operations |
| **Experiment-9** |
| 22. Program to create circular double linked list and implement its operations |
| **Experiment-10** |
| 23. Program to implement stack operations using linked list<br>24. Program to implement queue operations using linked list |
| **Experiment-11** |
| 25. Program to implement selection sort<br>26. Program to implement insertion sort |
| **Experiment-12** |
| 27. Program to implement shell sort<br>28. Program to implement radix sort<br>29. Program to implement hash table |
| **Textbook(s):**<br>1. D.Samantha, *Classic Data Structure,* Prentice Hall India New Delhi, 2nd edition, 2009 |
| **Reference Book(S):**<br>1. R. Thareja, *Data Structures Using C,* Oxford University Press, New Delhi, India, 2nd edition, 2014.<br>2. E. Balagurusamy, *Data Structure Using C*, McGraw Hill Education, New Delhi, India: 1st edition, 2017<br>3. R. F. Gilberg and B. A. Forouzan, *Data Structures: A Pseudocode Approach with C*, Cengage Learning, Boston, MA, USA, 2nd edition 2007 |
| **Web and Video link(s):**<br>*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):**<br>*Data Structure Through C Laboratory Manual and Record Book,* Department of IT, KITSW. |

| **Course Articulation Matrix (CAM):** | | **U24EE210: DATA STRUCTURE THROUGH C LABORATORY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE210.1** | 2 | 2 | 2 | 1 | - | - | 1 | 1 | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24EE210.2** | 2 | 2 | 2 | 2 | - | - | 1 | 1 | 1 | - | 2 | 2 | 2 |
| **CO3** | **U24EE210.3** | 2 | 2 | 2 | 2 | - | - | 1 | 1 | 1 | - | 2 | 2 | 2 |
| **CO4** | **U24EE210.4** | 2 | 2 | 2 | 2 | - | - | 1 | 1 | 1 | - | 2 | 2 | 2 |
| **U24EE210** | | **2** | **2** | **2** | **1.75** | **-** | - | **1** | **1** | **1** | **-** | **1.75** | **2** | **1.75** |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement** *The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | develop and test basic data structures and array operations, including dynamic memory allocation to evaluate their performance and complexity | SDG 4 | Quality education | These experiments build core computational thinking — traversal, searching, and dynamic memory management. Comparing linear vs binary search introduces algorithmic reasoning and efficiency trade-offs, directly reflecting SDG 4's goal of equipping learners with relevant, practical technical skills. DMA-based matrix operations further develop disciplined, structured problem-solving essential for quality engineering education. |
| CO2 | apply the linear data structures such as stacks and queues and perform various operations using LIFO or FIFO order respectively | SDG 9 | Industry, Innovation and Infrastructure | Stacks, queues, and expression evaluation are the structural foundation of compilers, OS schedulers, and runtime systems — real industrial infrastructure. Infix-to-postfix conversion mirrors how compilers parse code; queues model network packet management and CPU job scheduling. Recursion (Tower of Hanoi, Fibonacci) drives innovation in algorithm design, aligning strongly with SDG 9's emphasis on resilient, modern technological infrastructure. |
| CO3 | solve problems using various linked list representations for efficiently storing and retrieving the data | SDG 4 | Quality education | Linked list variants demand abstract thinking about pointers, dynamic memory, and node relationships — among the most cognitively demanding topics in undergraduate CS. Mastering singly, circular, doubly, and circular-doubly linked lists builds deep structural understanding, reflecting SDG 4's focus on high-quality, skill-building education. Reimplementing stacks and queues via linked lists reinforces conceptual reuse and flexible thinking. |
| CO4 | 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 | SDG 9 | Industry, Innovation and Infrastructure | Sorting algorithms and hash tables are indispensable in industry-grade systems — database query optimisation, search engine indexing, caching layers, and load balancers all depend on them. Radix sort is used in network routing; hash tables power key-value stores like Redis and DNS lookups. These experiments directly develop skills for building scalable, innovative digital |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | | | | infrastructure, the core of SDG 9. |

## III SEMESTER

| S. No. | Category | Course Code | Course Title | Lectures / week | | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | C |
| 1 | BSC | U24MH301G | Applied Mathematics | 2 | 1 | - | 3 | 3 |
| 2 | PCC | U24EE302 | Network Analysis | 2 | 1 | - | 3 | 3 |
| 3 | PCC | U24EE303 | Digital Electronics and Operational Amplifier | 2 | 1 | - | 3 | 3 |
| 4 | PCC | U24EE304 | DC Machines & Transformers | 2 | 1 | - | 3 | 3 |
| 5 | PCC | U24EE305 | OOP through Java | 2 | 1 | - | 3 | 3 |
| 6 | PCC | U24EE306 | Electromagnetic Fields | 2 | 1 | - | 3 | 3 |
| 7 | PCC | U24EE307 | Networks and Simulation Laboratory | - | - | 2 | 2 | 1 |
| 8 | PCC | U24EE308 | DC Machines & Transformers Laboratory | - | - | 2 | 2 | 1 |
| 9 | ESC | U24EE309 | OOP through Java Laboratory | - | - | 2 | 2 | 1 |
| | | | Total | 12 | 6 | 6 | 24 | 21 |
| **Summer/ Inter-semBridge 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)** | | | | **"Programming in C" bridge course for Non-CS/IT Lateral Entry students** | | | | |

# APPLIED MATHEMATICS

(*for Electrical & Electronics Engineering*)

| | | | |
|---|---|---|---|
| **Class:** B.Tech. III -Semester | | **Branch: Electrical & Electronics Engineering** | |
| **Course Code:** | **U24MH301G** | **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 Outcomes (COs):**

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

CO1: apply Laplace transforms to solve differential equations

CO2: represent a function as Fourier series

CO3: represent a given function in Taylor's and Laurent's series and evaluate integrals using integral theorems

CO4: interpret the data using various statistical measures and probability distributions

| **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); Initial value and final value theorems; 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 coefficients using Laplace transforms, Application of Laplace transforms to the first order and second order systems subjected to impulse, Step, Periodic, Rectangular, Square, Ramp, Triangular and Sinusoidal functions

| **UNIT-II** | **9 Hrs** |
|---|---|

**Fourier Series:** Periodic functions, Orthogonal and orthonormal functions and systems of orthogonal functions, Representation of a function as trigonometric Fourier series (FS) in a range of length 2π, Euler formulae, Conditions for the existence of Fourier series (Dirichlet's conditions), FS for typical wave forms - Square wave, Pulse train, Impulse train(comb function), Periodic rectangular wave, Triangle, Saw-tooth, Half-wave rectified signal, Full-wave rectified signal; Plotting FS coefficients - Line spectrum (magnitude and phase spectra); Effects of symmetry of function on FS coefficients, Exponential FS ,Fourier series of , and combination of Sinusoids, Fourier series on an arbitrary period; Half range series – Half range cosine and sine series expansions

| **UNIT-III** | **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, 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

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Statistical Methods:** Measures of central tendency-Mean, Median, Mode, Measures of dispersion-Standard deviation and Variance, correlation coefficient, rank correlation, regression – Linear regression equations

**Probability and Distributions:** Review of the concepts of probability, conditional probability, Random variable, Discrete probability distribution and continuous probability distribution, Binomial distribution, Poisson distribution, mean and variance of distributions, and Normal distribution

**Applications:** fitting of Binomial distribution, Poisson distribution to the given real time data

**Textbook(s):**

1. Grewal, B.S., *Higher Engineering Mathematics*, 44th ed., New Delhi: Khanna Publishers, 2017

**Reference Book(s):**

1. SP Ghosh and AK Chakraborty., *Network Analysis and Synthesis*, McGraw HILL. Publication 2nd edition, 2014
2. Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab, *Signals & Systems,* 2nd ed., NJ, USA: Prentice-Hall International Inc., (signal processing series), 1997
3. Churchill R.V., *Complex Variable and its Applications*, 9th ed., New York, USA: McGraw Hill, 2013.
4. Kreyszig E, *Advanced Engineering Mathematics*, 10th ed., U.K: John Wiely & Sons, 2020
5. S.P. Gupta, *Statistical Methods*, 46th ed., New Delhi: Sultan Chand & Sons, 2023.

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

1. *https://archive.nptel.ac.in/courses/111/106/111106139/ : NPTEL Video Lecture on Laplace transform/ PROF. INDRAVA ROY/ Institute of Mathematical Sciences Chennai.*
2. https://youtu.be/HoGNkZclxDU?si=K9DFQ4jVL1OQiArb : *NPTEL Video Lecture on Fourier Series and its Convergence/Dr.S.K.Gupta /IIT Roorkee*
3. https://onlinecourses.nptel.ac.in/noc25_ma33/preview?user_email=dsreddy.hari@gmail.com:

*NPTEL Video Lecture on Introduction to Probability Theory and Statistics by Prof. S Dharmaraja, IIT Delhi*

| **Course Articulation Matrix (CAM):** | | **U24MH301G: APPLIED MATHEMATICS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PSO1** | **PSO2** |
| **CO1** | **U24MH301G.1** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24MH301G.2** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **CO3** | **U24MH301G.3** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **CO4** | **U24MH301G.4** | 2 | 2 | 1 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **U24MH301B** | | **2** | **2** | **1** | **1** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **1** |

# NETWORK ANALYSIS

| | | | |
|---|---|---|---|
| **Class:** B.Tech. III -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE302** | **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 Outcomes (COs):**

*After completion of this course, the students should be able to,*
*(based on cognitive skills acquired from theory component)*

**CO1**: analyse electrical circuits using appropriate network theorems

**CO2**: determine transient & steady state response of RLC circuits with step, sinusoidal & other special signals

**CO3**: determine the parameters of a two-port network and draw its equivalent circuit.

**CO4**: analyse network functions and synthesize RL, RC, and LC networks using Foster and Cauer forms.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Network Theorems**: Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Tellegen's theorem, Superposition theorem, Reciprocity theorem, Compensation theorem and Substitution theorem.

**Coupled Circuits**: Introduction, Mutual inductance, Direction of self and mutual Induced EMF, Dot convention for coupled coils, Coupled coils in series, Coupled coil in parallel, Transformer as a coupled circuit.

***Self-Learning Topics (SLTs):*** *Mesh & Nodal analysis (Text1: Chapter2-Topic 2.5, Problems: 2.41, 2.51), Solved problems (Text1: Prob 2.42,2.43, 2.52, 2.53), Practice problems (Text1: Prob 6,7,8,9).*

| **UNIT-II** | **9 Hrs** |
|---|---|

**Time response analysis of networks:** Transient analysis of R-L, R-C, R-L-C series and parallel networks with Step, Impulse, Sinusoidal and Pulse excitation-Initial conditions-Special signal waveforms-Ramp, Triangular, Train of pulses, Delayed input.

***Self-Learning Topics (SLTs):*** *(Text1: Chapter8- Topic 8.2, ; Example 8.3,8.4, Chapter9-Topic 9.2,9.3,9.4,9.5) Solved problems (Text1: Prob 8.8,8.9), Practice problems (Text1: Prob 7,8,9)*

| **UNIT-III** | **9 Hrs** |
|---|---|

**Two port networks**: Characterizations of linear time invariant two port networks - Open circuit impedance parameters, Short circuit admittance parameters, Transmission parameters, Inverse-transmission parameters, Hybrid parameters, Inverse-hybrid parameters, Symmetry and reciprocity conditions in terms of two-Port parameters.

**Interconnections of two-port networks**: Ladder network, Bridged-T, parallel-T and lattice-T networks, Terminated two-Port networks.

***Self-Learning Topics (SLTs):*** *Solved problems (Text1: Prob 13.28,13.29,13.32,13.35), Practice problems (Text1: Prob 1,9,10)*

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Network Functions:** Network functions for 1-port and 2-port networks and their relationships Ladder Networks - General Networks - Poles and Zeros of Network functions - Restrictions on poles and zeros of driving point impedances.

**Network Synthesis:** Positive real function properties - Hurwitz Polynomials - Even and odd functions - Test for positive Real functions - Elementary synthesis operation - Properties and Foster and Cauer forms of RL, RC and LC networks.

**Self-Learning Topics (SLTs):** *Solved problems (Text1: Prob 21.16, Prob 21.17, Prob 21.18)*

**Textbook(s):**

1. A. Chakrabarti, "*Circuit Theory Analysis and Synthesis*", Dhanpat Rai & Co, 7th ed.,, 2017.

**Reference Book(s):**

1. M.E. Van Valken Burg, "*Network Analysis*", Pearson Education 3rd ed., , 2006
2. W.H. Hayt and Jr. Kemmerly, "*Engineering Circuit Analysis*", McGraw-Hill Higher Education, 7th ed., 2006

3. D. Roy Choudhary, "*Network analysis and Synthesis*", New age Publishers, 1st ed., , 2006
4. K. A. Gangadhar, "*Circuit Theory*", Khanna Publishers, 2nd, ed., , 2006
5. Parker Smith, "*Problems in Electrical Engineering*", CBS Publishers, 1st ed., , 2010
6. A. Sudhakar, Shyammohan S. Palli – "*Circuits and networks*" McGraw-Hill Education, 2015, Fifth edition.

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

https://nptel.ac.in/courses/108/105/108105159/; *NPTEL Video Lecture on Network Analysis by Prof. Tapas Kumar Bhattacharya, Professor of EED, IIT Kharagpur.*

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

1. *Networks & Simulation Laboratory Manual,* Department of EEE, KITSW.

| **Course Articulation Matrix (CAM):** | | **U24EE302 NETWORK ANALYSIS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE302.1** | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24EE302.2** | 2 | 2 | 2 | 1 | 1 | - | - | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO3** | **U24EE302.3** | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | 1 | 1 | 2 | 1 |
| **CO4** | **U24EE302.4** | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **U24EE302** | | 2 | 2 | 1.25 | 1 | 1 | **-** | - | 1 | 1 | 0.5 | 1 | 2 | 1 |

# DIGITAL ELECTRONICS AND OPERATIONAL AMPLIFIERS

| | | | |
|---|---|---|---|
| **Class:** B.Tech. III -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE303** | **Credits:** | **3** |
| **Hours/Week (L-T-P-O-E):** | **2-1-0-0-3** | **CIE:** | **40 Marks** |
| **Total Number of Teaching Hours:** | **36 Hrs.** | **ESE:** | **60 Marks** |

**Course Learning Outcomes (COs):**

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

**CO1:** simplify Boolean expressions and minimize SOP/POS forms of switching functions using Karnaugh Map & Tabulation methods

**CO2:** design combinational and sequential circuits such as adders, subtractors, code converters, encoders, decoders, multiplexers, demultiplexers, counters and shift registers

**CO3:** design Op-Amp based simple linear & non-linear circuits for the given specifications

**CO4:** design IC 555 timer-based application circuits and choose suitable data converter for given design specifications

| **UNIT-I** | **9 Hrs.** |
|---|---|

**Number systems and Codes:** Review of number systems, binary arithmetic, binary weighted and non-weighted codes

**Boolean Algebra:** Postulates and theorems, logic gates and truth tables, representation, minimization and realization of switching functions, SOP & POS forms, minimization using Karnaugh map and Quine - McClusky Techniques

***Self-Learning Topics (SLTs):*** *Signed number representation (Text1: topic 1.5), 1's and 2's complement subtraction, BCD and XS-3 arithmetic (Text1: topic 1.6, 1.7)*

| **UNIT-II** | **9 Hrs.** |
|---|---|

**Combinational circuits:** Design of combinational circuits using logic gates – half adder, full adder, half subtractor, full subtractor, BCD adder, decoders, encoders, multiplexers, demultiplexers, realization of switching functions using multiplexers and decoders

**Sequential circuits:** Flip flops – SR, JK, D and T flip flops, master slave flip flop, binary counters – design of synchronous and asynchronous counters, shift registers – modes of operation, ring counter and Johnson counter

***Self-Learning Topics (SLTs):*** *Code converters (Text1: topic 4.4), 1's and 2's complement adder/subtractor (Text1: topics 4.5), Parity generators (Text1: topics 4.5), problems (Text1: Prob 4.10, 4.12, 4.16, 4.34, 4.35)*

| **UNIT-III** | **9 Hrs** |
|---|---|

**Operational Amplifier (Op-Amp):** Building blocks of Op-Amp, analysis of basic inverting & non-inverting amplifier configurations, DC & AC characteristics of Op-Amp

**Linear Applications of Op-Amp:** Summing and difference amplifiers, integrator, differentiator, voltage to current converter, current to voltage converter, sample and hold circuit

**Non-linear Applications Op-Amp:** Precision rectifiers–half and full wave rectifiers, Log amplifier, Op-Amp comparators

***Self-Learning Topics (SLTs):*** *Differential amplifiers -balanced & unbalanced (Text2: topics 2.1, 2.2, 2.6), Fabrication process of IC (Text2: Prob 2.4, Prob 2.5, Prob 2.7), Anti-log amplifier (Text2: topics 3.1, 3.2, 3.6), Solved problems (Text2: Prob 3.4, Prob 3.5, Prob 3.7)*

| **UNIT-IV** | **9 Hrs** |
|---|---|

**IC 555 timer:** Introduction, functional diagram, design of astable and monostable multivibrators using 555timer, application of astable multivibrator-FSK generator; application of monostable multivibrator-linear ramp generator

**Data Converters:** DAC types –Weighted resistor, R-2R ladder; ADC types - Flash, Successive approximation & Dual slope

***Self-Learning Topics (SLTs): Self-Learning Topics (SLTs):*** *Applications of IC 555 Timer: Pulse-Position modulation, Missing pulse detector, Pulse-width modulation (Text2: topics 4.1, 4.2, 4.6), Solved problems (Text2: Prob 4.4, Prob 4.5, Prob 4.7)*

**Textbook(s):**

1. M. Morris Mano, *Digital Design*, 5th ed. New Delhi: PHI, 2013 (Chapters 1 to 7)
2. D. Roy Choudhury and Shail B Jain, *Linear Integrated Circuits*, New Age International, New Delhi, 4th 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

| **Course Articulation Matrix (CAM)** | | **U24EE303 DIGITAL ELECTRONICS AND OPERATIONAL AMPLIFIERS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** | **U24EE303.1** | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO2** | **U24EE303.2** | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO3** | **U24EE303.3** | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | **U24EE303.4** | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **U24EE403** | | **2** | **2** | **1** | **1** | **1** | **-** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW | | | | | | | | | | | | | | |

| **CO–SDG Alignment Matrix** | | | | |
|---|---|---|---|---|
| **CO** | Mapped POs | Mapped SDGs | SDG Description | Justification |
| CO1: Apply number systems, Boolean algebra, logic gates, and minimization techniques to design and analyze digital logic circuits. | PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2 | SDG 4, SDG 9 | Quality Education, Industry, Innovation and Infrastructure | Applies engineering fundamentals and analytical skills for digital circuit design using modern tools. Contributes to quality engineering education (SDG 4) and technological innovation in digital electronics (SDG 9). |
| CO2: Design and analyze combinational and sequential logic circuits using flip-flops, counters, registers, multiplexers, and decoders. | PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2 | SDG 4, SDG 8, SDG 9 | Quality Education, **:** Decent Work and Economic Growth, Industry, Innovation and Infrastructure | Develops design and problem-solving skills for digital systems widely used in industrial automation and embedded systems, supporting employability (SDG 8) and industrial innovation (SDG 9). |
| CO3: Analyze and design linear and non-linear operational amplifier circuits | PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PO10, | SDG 4, SDG 7, SDG 9 | Quality Education, Affordable and Clean Energy, Industry, Innovation and | Enhances knowledge of analog electronic systems used in energy-efficient instrumentation, communication, healthcare, |

| | | | | |
|---|---|---|---|---|
| for analog signal processing applications. | PO11, PSO1, PSO2 | | Infrastructure | and control systems, contributing to clean energy technologies (SDG 7) and innovation (SDG 9). |
| CO4: Design timer circuits and data converters using IC 555, DACs, and ADCs for practical electronic system applications. | PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2 | SDG 4, SDG 7, SDG 9, SDG 12 | Quality Education , Affordable and Clean Energy, Industry, Innovation and Infrastructure, Responsible Consumption and Production | Develops practical electronic system design skills for embedded systems, IoT, automation, and efficient electronic products. Promotes responsible engineering practices (SDG 12) and sustainable technological development (SDG 7 & SDG 9). |

# DC MACHINES AND TRANSFORMERS

| | | | |
|---|---|---|---|
| **Class:** B.Tech. III -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE304** | **Credits:** | **3** |
| **Hours/Week (L-T-P-O-E):** | **2-1-0-4-7** | **CIE Marks:** | **60 %** |
| **Total Number of Teaching Hours:** | **36 Hrs** | **ESE Marks :** | **40 %** |

**Course Learning Outcomes (COs):**

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

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

**CO1**: apply the principles of electromechanical energy conversion to determine the force, torque, core losses and emf produced in singly excited and doubly excited systems and apply the concepts of constructional features to determine the induced emf in DC generators

**CO2**: design the compensating winding to minimize the demagnetization and cross magnetization effect of armature reaction for improved commutation in DC machines and analyse the characteristics of DC machines & determine the critical field resistance and critical speed for self-excitation

**CO3**: evaluate DC motor starting methods & speed control techniques for a given application and analyse the DC motor performance from various testing methods

**CO4**: analyse the performance of 1-phase transformer from various testing methods; compare the performance of auto transformer and select 3-phase transformer for a given application

| **UNIT-I** | **9 Hrs** |
|---|---|

**Magnetic Circuits:** Series and Parallel Magnetic Circuits Core with air gap B-H relationship (Magnetization Characteristics), Hysteresis with dc and ac excitation Hysteresis Loss and Eddy Current Loss, Faraday's Law of Electromagnetic Induction, Statically and Dynamically Induced EMF, Force on Current Carrying Conductor

**Basic concepts of Rotating Electrical machines:** Basic constructional features of rotating electrical machines. Principle of operation, Armature windings, Simplex and Multiplex lap and wave windings (Elementary Treatment). Types of dc generators, Emf equation

***Self-Learning Topics (SLTs):*** *Principles of Electromechanical Energy Conversion, Singly and Doubly excited systems Solved problems (Text1: Section 2.2 a) Electric energy input b) Magnetic field energy stored c) Mechanical work done, Example 2.1, Example 2.2) Practice problems (Text1: Section 2.4, Example 2.13).*

| **UNIT-II** | **9 Hrs** |
|---|---|

**DC Generators: Armature reaction & Commutation:** Demagnetizing and cross magnetizing Ampere Turns, Interpoles, Compensating windings. Commutation, Reactance voltage, Methods of improving commutation

**Characteristics of dc Generators:** Methods of excitation, Separately and Self excited generators. Voltage build-up process in shunt generators, Critical field resistance and Critical speed. Characteristics & Applications of Shunt, Series & compound generators

***Self-Learning Topics (SLTs):****,Critical field resistance and critical speed calculations for series and compound generators (Text1: Section 4.11.2, Example 4.19)*

| **UNIT-III** | **9 Hrs** |
|---|---|

**D.C. Motors:** Principle of operation, Back emf, Torque Equation, Classification of dc motors. Starters, Operating Characteristics and Speed Control of dc motors

**Testing of dc Machines**: Losses and Efficiency, Brake Test, Swinburne's Test, Hopkinson's Test, Field's Test, Applications of dc motors

***Self-Learning Topics (SLTs):*** *Braking of dc motors: Solved problems (Text1: Sections 4.14, 4.14.1, 4.14.2, 4.14.3 Example 4.40, Example 4.41, Example 4.42, 4.46)*

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Transformers: Single Phase Transformers:** Constructional features, principle of operation, Emf equation, and operation on no load and on load, Phasor diagrams. Equivalent circuit, determination of equivalent circuit parameters. Voltage Regulation. Determination of losses and efficiency by Open Circuit (OC), Short Circuit (SC) tests. Parallel operation, Load sharing

**Auto Transformer:** Principle of working, saving of copper as compared to two winding Transformer and applications

**Three Phase Transformers:** Types of connections, Relation between line and phase voltages and currents, Use of Tertiary winding, off load and on load tap changing of transformers

***Self-Learning Topics (SLTs):*** *Sumpner's test, Scott connection of transformers, Separation of Core losses, All day efficiency. Three winding Transformer, induction Regulator. Solved problems (Text1: Sections 1.11, 1.13 Example 1.36 Example 1.49, Text1: Section 1.14 Example 1.55, Example 1.56 Text1: Section 1.15)*

**Text Books:**

**1.** Bimbhra P.S., *Electric Machinery,* Khanna Publisher, 7th ed, 2014

**Reference Books:**

1. Bimbhra P.S., *Generalized Machine Theory*, Khanna Publisher, 5th ed, 2014
2. Chakrabarthy, *Electric Machines*, McGraw Hill, Publications, 2015
2. A.E. Fitzgerald, Kingsly, Stephen., *Electric Machinery*, Tata McGraw Hill, 2015
3. Stephen J.Chapman *Electric Machinery Fundamentals*, Tata McGraw Hill, 4th ed, 2015
4. Nagrath and Kotari, *Electrical Machines* Tata McGraw Hill, 4th ed, 2004.

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

1. *NPTEL :: Electrical Engineering - NOC:Electrical Machines - I*
2. *NPTEL :: Electrical Engineering - Electrical Machines I*

| **Course Articulation Matrix (CAM):** | | **U24EE304 DC MACHINES & TRANSFORMERS** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE304.1** | 3 | 3 | 3 | 1 | 1 | 1 | - | - | - | 1 | 1 | 3 | 2 |
| **CO2** | **U24EE304.2** | 3 | 3 | 3 | 1 | 1 | 1 | - | - | - | 1 | 1 | 3 | 2 |
| **CO3** | **U24EE304.3** | 3 | 3 | 3 | 1 | 1 | 1 | - | - | - | 1 | 1 | 3 | 2 |
| **CO4** | **U24EE304.4** | 3 | 3 | 3 | 1 | 1 | 1 | - | - | - | 1 | 1 | 3 | 2 |
| **U24EE304** | | **3** | **3** | **3** | **1** | **1** | **1** | **-** | **-** | **-** | **1** | **1** | **3** | **2** |

# OBJECT ORIENTED PROGRAMMING THROUGH JAVA

| | | | |
|---|---|---|---|
| **Class:** B.Tech. III –Semester | | **Branch:** Common to All | |
| **Course Code:** | **U24EE305** | **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 Outcomes (COs):**

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

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

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

**Reference Book(s):**

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

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

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): | | U24CS305: OBJECT ORIENTED PROGRAMMING THROUGH JAVA | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | U24CS305.1 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | 1 | 1 | 1 |
| CO2 | U24CS305.2 | 2 | 2 | 2 | 1 | 2 | - | - | 1 | - | - | 1 | 1 | 1 |
| CO3 | U24CS305.3 | 2 | 2 | 3 | 2 | 1 | - | - | - | - | - | 1 | 2 | 2 |
| CO4 | U24CS305.4 | 2 | 2 | 3 | 2 | 2 | - | - | 1 | - | - | 1 | 2 | 2 |
| U24CS305 | | **2** | **2** | **2.5** | **1.25** | **1.5** | **-** | **-** | **0.5** | **-** | **-** | **1** | **1.5** | **1.5** |

# ELECTROMAGNETIC FIELDS

| | | | |
|---|---|---|---|
| **Class:** B.Tech. III -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE306** | **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:** principles of electrostatics, including coordinate systems to analyze and solve electric field problems and relate field theory concepts to circuit theory.

**CO2:** concepts of electric dipoles, dielectric materials, and capacitance to analyze electrostatic fields, including evaluation of potential and electric field with current density and charge transport mechanisms.

**CO3:** magnetic fields and forces, including evaluation of fields and determination of magnetic flux and potentials, and assessment of forces on charges and current elements.

**CO4:** inductance for various current configurations, correlating the results with the underlying electromagnetic principles, and critically interpret Maxwell's equations in the context of time-varying fields.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction:** Cartesian, Cylindrical and Spherical Co-ordinate Systems,Field theory Vs. Circuit theory.

**Static Electric Fields:** Coulomb's law, Electric field intensity, Field due to different charge configurations, Electric flux, Electric flux density, Gauss' law and its applications, Divergence theorem, Relation between D and E, Work done in moving a unit positive charge, Electric potential, Absolute potential, Potential difference between two points and its independence in path of integration, Relation between E and V.

| **UNIT-II** | **9 Hrs** |
|---|---|

Dipoles: Potential and electric field at a point due to electric dipole, Torque on electric dipole when placed in electric field, Polarization in dielectrics, Dielectric strength & constant, Dielectric loss, Boundary conditions between dielectrics.

**Boundary value problems:** Laplace's and Poisson's equations

**Capacitance:** Capacitance of parallel plate, Cylindrical and spherical capacitors,Current density.

| **UNIT-III** | **9 Hrs** |
|---|---|

Static Magnetic fields: Concept of magnetic field, Biot- Savart's law, Ampere's circuit law and its applications, Magnetic flux and magnetic flux density, Magnetic field caused by different types of current configurations, Scalar and vector magnetic potentials, Calculation of vector magnetic potentials for simple cases, Vector Poisson's equation.

Magnetic Forces: Force on a moving charge, Force on a differential current element, Force between differential current elements, Magnetic boundary conditions, Magnetic dipole.

| **UNIT-IV** | **9 Hrs** |
|---|---|

Inductance: Faraday's law, Lorentz force, Magnetomotive force,Displacement current, Self and mutual inductance of simple configurations.

**Maxwell's equations:** Maxwell's equations for static electric fields and study magnetic fields, Maxwell's equations for time varying fields in point and integral form

**Textbook(s):**

1. K. A. Gangadhar, *Field Theory*, Khanna Publishers ,8th ed., 2015,New Delhi

**References Books:**

1. W. H Hayt (Jr.), *Engineering Electromagnetics*, Tata McGraw Hill Education (India) Pvt. Ltd, 8th ed., 2014,New Delhi

2. Mathew. N. O. Sadiku, *Elements of Electromagnetics*,Oxford University press,7th ed., 2018,New Delhi
3. David J. Griffiths, *Introduction to Electrodynamics*, Pearson Ind Pvt.Ltd,4th ed.,2013 New Delhi

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

1. https://archive.nptel.ac.in/courses
2. https://www.youtube.com/watch?v=FtEShPAFpek&list=PL_mruqjnuVd87sjSDVS9wuit9CSpgIIfx

| Course Articulation Matrix (CAM) | | U24EE306: ELECTROMAGNETIC FIELDS (EMF) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | U24EE306.1 | 3 | 3 | 1 | 1 | 1 | 1 | - | - | - | - | - | 3 | 1 |
| CO2 | U24EE306.2 | 3 | 3 | 2 | 1 | 2 | 1 | - | - | - | - | - | 3 | 1 |
| CO3 | U24EE306.3 | 3 | 3 | 1 | 2 | 2 | 1 | - | - | - | - | - | 3 | 1 |
| CO4 | U24EE306.4 | 3 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 3 | 1 |
| U24EE306 | | **3** | **3** | **1.5** | **1.5** | **1.75** | **1** | **-** | **-** | **-** | **-** | **-** | **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** | Apply principles of electrostatics, including coordinate systems to analyze and solve electric field problems and relate field theory concepts to circuit theory | **SDG 9** | Industry, Innovation and Infrastructure | A strong understanding of electrostatics enables students to analyze electric fields in components such as capacitors and insulation systems, which are fundamental to reliable power and communication infrastructure. The ability to connect field theory with circuit models supports accurate design, simulation, and optimization of engineering systems used in industries. |
| **CO2** | concepts of electric dipoles, dielectric materials, and capacitance to analyze electrostatic fields, including evaluation of potential and electric field with current density and charge transport mechanisms | **SDG 9** | Industry, Innovation and Infrastructure | Understanding dipoles, dielectric behavior, and capacitance is fundamental for **insulation design, energy storage devices capacitors and electronic components**, which are widely used in industrial and infrastructure applications. Concepts such as current density and charge transport mechanisms are critical in analyzing material performance in devices like cables, semiconductors, and high-voltage equipment. |
| **CO3** | magnetic fields and forces, including evaluation of fields and determination of magnetic flux and potentials, and assessment of forces | **SDG 9** | Industry, Innovation and Infrastructure | Understanding magnetic fields and forces for the development and operation of electric machines, transformers, inductors, and electromagnetic devices, which form the backbone of modern industrial infrastructure. The ability to evaluate |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement** *The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | on charges and current elements | | | magnetic flux and potentials enables engineers to design efficient energy conversion systems and optimize performance. |
| **CO4** | inductance for various current configurations, correlating the results with the underlying electromagnetic principles, and critically interpret Maxwell's equations in the context of time-varying fields | **SDG11** | Sustainable cities and communities | A strong understanding of inductance and time-varying electromagnetic fields governed by Maxwell's Equations is essential for designing systems such as power transmission networks, transformers, wireless communication systems, and electromagnetic compatibility solutions, all of which are critical in modern cities |

# NETWORKS AND SIMUATION LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B.Tech. III -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE307** | **Credits:** | **4** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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: validate network theorems and evaluate the coefficient of coupling in coupled coils.
CO2: determine network parameters for a given two port network
CO3: validate mesh and nodal analysis using MATLAB
CO4: determine the transient response of electrical network using MATLAB

**Laboratory Experiments**

1. Verification of superposition theorem
2. Verification of Thevenin's theorem
3. Verification of maximum power transfer theorem
4. Verification of reciprocity theorem
5. Determination of Z-parameters of two-port network
6. Determination of Y-parameters of two-port network
7. Determination of ABCD parameters of two-port network
8. Determination of hybrid parameters of two-port network
9. Determination of loop currents of the given circuit using MATLAB software
10. Determination of nodal voltages of the given circuit using MATLAB software
11. Time response analysis of electrical network using MATLAB software
12. Determination of self, mutual inductance and coefficient of coupling of coupled coils.

**Textbook(s):**

A. Chakrabarti, "*Circuit Theory Analysis and Synthesis*", Dhanpat Rai & Co, 7th ed.,, 2017.

**Reference Book(s):**


4. M.E. Van Valken Burg, "*Network Analysis*", Pearson Education 3rd ed., , 2006
5. W.H. Hayt and Jr. Kemmerly, "*Engineering Circuit Analysis*", McGraw-Hill Higher Education, 7th ed., , 2006
6. D. Roy Choudhary, "*Network analysis and Synthesis*", New age Publishers, 1st ed., , 2006
7. K. A. Gangadhar, "*Circuit Theory*", Khanna Publishers, 2nd, ed., , 2006
8. Parker Smith, "*Problems in Electrical Engineering*", CBS Publishers, 1st ed., , 2010
9. A. Sudhakar, Shyammohan S. Palli – "*Circuits and networks*" McGraw-Hill Education, 2015, Fifth edition.


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

https://nptel.ac.in/courses/108/105/108105159/; *NPTEL Video Lecture on Network Analysis by Prof. Tapas Kumar Bhattacharya, Professor of EED, IIT Kharagpur.*

| **Course Articulation Matrix (CAM):** | | **U24EE307 NETWORKS AND SIMAULATION LABORATORY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE307.1** | 3 | 3 | 2 | 1 | - | - | 1 | 3 | 2 | 2 | 1 | 2 | 1 |
| **CO2** | **U24EE307.2** | 3 | 3 | 2 | 1 | - | - | 1 | 3 | 2 | 2 | 1 | 2 | 1 |
| **CO3** | **U24EE307.3** | 3 | 3 | 3 | 1 | 2 | - | 1 | 3 | 2 | 2 | 2 | 2 | 1 |
| **CO4** | **U24EE307.4** | 3 | 3 | 3 | 1 | 2 | - | 1 | 3 | 2 | 2 | 2 | 2 | 1 |
| **U24EE307** | | 3 | 3 | 2.5 | 1 | 2 | **-** | 1 | 3 | 2 | 2 | 1.5 | 2 | 1 |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | validate network theorems and evaluate the coefficient of coupling in coupled coils. | SDG4 | Quality Education | Experimental validation of network theorems and magnetic coupling concepts strengthens practical understanding of electrical circuits and develops laboratory skills essential for designing and testing reliable electrical systems, supporting quality engineering education and industrial innovation. |
| CO2 | determine network parameters for a given two port network | SDG9 | Industry, Innovation and Infrastructure | Determination of two-port network parameters equips students with practical skills for analysing communication, instrumentation, and power electronic systems. These competencies contribute to the development of modern industrial infrastructure and engineering innovation. |
| CO3 | validate mesh and nodal analysis using MATLAB | SDG9 | Industry, Innovation and Infrastructure | MATLAB-based validation of mesh and nodal analysis enhances computational and analytical skills while introducing students to industry-standard simulation tools used in electrical system design and analysis, thereby promoting innovation and high-quality technical education. |
| CO4 | determine the transient response of electrical network using MATLAB | SDG7 | Affordable and Clean Energy | Simulation of transient responses enables the design of stable, reliable, and energy-efficient electrical systems. The use of MATLAB supports modern engineering practices that improve the performance of power systems, renewable energy applications, and industrial automation. |

# DC MACHINES & TRANSFORMERS LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. III – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE308** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-0** | **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 :** obtain performance characteristics of DC generators
**CO2 :** determine performance characteristics of DC motors and transformers
**CO3 :** predetermine the performance characteristics of DC machines using Swinburne's test and transformers using OC, SC tests
**CO4 :** acquire hands-on experience on connections of 3-phase transformers

1. Magnetization characteristics of separately excited dc generator.
2. Determination of load characteristics of dc shunt generator.
3. Predetermine the efficiency of dc machine by Swinburne's test.
4. Determination of performance characteristics of dc series motor by brake test.
5. Determination of performance characteristics of dc shunt motor by brake test.
6. Determination of performance characteristics dc Compound motor by brake test
7. Speed Control of dc Shunt motor.
8. Predetermine the efficiency of 1-phase transformer by open circuit and short circuit tests.
9. Determination of voltage regulation and efficiency of 1-phase transformer by conducting load test
10. Determination of efficiency of 1-Φ transformer by conducting Sumpner's test
11. Scott connection of transformer
12. Parallel operation of two single phase transformers.

**Textbook(s):**

S.G. Tarnekar, P.K. Kharbanda —Laboratory Courses in Electrical Engineering, S.*Chand& Company Limited*, 4/e, 2003.

**Reference Book(S):**

P.S.Bhimbra, Electrical Machinery, Khanna publications, New Delhi, fully revised edition,2021

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

https://www.youtube.com/watch?v=BVTJHXqQFxQ&list=PLSnw1KE0TFkVjEVeh-lkiMh2nz6vhwQrg

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

Manual for —Electrical Machines- I *Laboratory* prepared by the Department of EEE

| **Course Articulation Matrix (CAM)** | | **U24EE308: DC MACHINES & TRANSFORMERS 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** | **U24EE308.1** | 3 | 2 | 1 | 1 | 1 | - | - | 1 | 3 | 2 | - | 3 | 2 |
| **CO2** | **U24EE308.2** | 3 | 2 | 1 | 1 | 1 | - | - | 1 | 3 | 2 | - | 3 | 2 |
| **CO3** | **U24EE308.3** | 3 | 2 | 1 | 1 | 1 | - | - | 1 | 3 | 2 | - | 3 | 2 |
| **CO4** | **U24EE308.4** | 3 | 2 | 1 | 1 | 1 | - | - | 1 | 3 | 2 | - | 3 | 2 |
| **U24EE308** | | **3** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **3** | **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** | obtain performance characteristics of DC generators | SDG 7 | Affordable and Clean Energy | Understanding the performance characteristics of DC generators helps in efficient electrical energy generation and utilization, contributing to sustainable and clean energy systems. |
| **CO2** | determine performance characteristics of DC motors and transformers | SDG 9 | Industry, Innovation and Infrastructure | Analysis of DC motors and transformers supports the development of reliable industrial systems, efficient electrical infrastructure, and technological innovation. |
| **CO3** | predetermine the performance characteristics of DC machines using Swinburne's test and transformers using OC, SC tests | SDG 12 | Responsible Consumption and Production | Performance prediction and testing techniques improve energy efficiency, reduce wastage, and promote optimal utilization of electrical equipment and resources. |
| **CO4** | acquire hands-on experience on connections of 3-phase transformers | SDG 11 | Sustainable Cities and Communities | Practical knowledge of transformer connections contributes to reliable power distribution systems essential for sustainable urban infrastructure and community development. |

# OOPS THROUGH JAVA LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. III – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE309** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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,*
*(based on psychomotor skills acquired from laboratory component)*

**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

**Experiments**

**Experiment-I:**

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

**Experiment-II:**

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

**Experiment-III:**

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

**Experiment-IV:**

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

**Experiment-V:**

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

**Experiment-VI:**

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

**Experiment-VII:**

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

**Experiment-VIII:**

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

**Experiment-IX:**

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

**Experiment-X:**

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

**Experiment-XI:**

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

**Experiment-XII:**

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

**Textbook(s):**

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.

**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.

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

*Object Oriented Programming through java Manual and Record Book,* Department of CSE, KITSW.

| **Course Articulation Matrix (CAM):** | | **U24EE309 : OOPS THROUGH JAVA LAB** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24CS309.1** | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **CO2** | **U24CS309.2** | 1 | 2 | 2 | 2 | 2 | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **CO3** | **U24CS309.3** | 1 | 2 | 3 | 2 | 2 | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO4** | **U24CS309.4** | 1 | 2 | 3 | 2 | 2 | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **U24EE309** | | 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 | analyze the strengths and limitations of various programming paradigms to determine their suitability for solving various programming problems in java | SDG4 | Quality Education | Builds computational thinking and programming fundamentals. |
| CO2 | develop java programs using classes, constructors, methods and various string concepts. | SDG9 | Industry, Innovation and Infrastructure | Object-oriented software development supports industrial innovation. |
| CO3 | apply reusability concepts like inheritance, dynamic method dispatch, interfaces and packages to build java programs. | SDG9 | Industry, Innovation and Infrastructure | Reusable software architecture and modular design improve sustainable software engineering. |
| CO4 | develop java programs using I/O, file handling, exception handling and multithreading concepts | SDG9 | Industry, Innovation and Infrastructure | Reliable applications using I/O, exception handling, and multithreading are essential for industrial and enterprise software systems. |

## IV SEMESTER

| S. No. | Category | Course Code | Course Title | Lectures / week | | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | C |
| 1 | PCC | U24EE401 | Control Systems Engineering | 2 | 1 | - | 3 | 3 |
| 2 | PCC | U24EE402 | AC Machines | 2 | 1 | - | 3 | 3 |
| 3 | PCC | U24EE403 | Signals and Systems | 2 | 1 | - | 3 | 3 |
| 4 | PCC | U24EE404 | Power System Generation & Distributions | 2 | 1 | - | 3 | 3 |
| 5 | ESC | U24EE405 | Python Programming | 2 | 1 | - | 3 | 3 |
| 6 | VAC | U24VA406B | Soft & Interpersonal Skills | - | - | 2 | 2 | 1 |
| 7 | PCC | U24EE408 | Control Systems Engineering Laboratory | - | - | 2 | 2 | 1 |
| 8 | PCC | U24EE409 | Electrical Machines Laboratory | - | - | 2 | 2 | 1 |
| 9 | ESC | U24EE410 | Python Programming Laboratory | - | - | 2 | 2 | 1 |
| | | | Total | 10 | 5 | 8 | 23 | 19 |
| 10 | VAC* | U24CY411* | Environmental Science (For lateral entry students only) | 2 | - | - | 2 | 1 |
| | | | Total (For lateral entry students only) | 12 | 5 | 8 | 25 | 20 |
| **Summer/ Inter-semBridge 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)** | | | | **NIL** | | | | |

**Bridge Courses for exit:**

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

**(OR)**

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

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

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

| **Exit Option to Qualify UG Diploma in EEE: Any Two (02) Courses during the 2 - Months internship** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S. No. | Category | Course Code | Course Title | L | T | P | O | E | C |
| 1 | PCC | U24EE411X | Working, Servicing, and Repair of Electrical Appliances | 2 | - | 2 | - | 4 | 3 |
| 2 | PCC | U24EE412X | Electrical Design, Drawing and Estimation | 2 | - | 2 | - | 4 | 3 |
| 3 | PCC | U24EE413X | Testing and maintenance of DC machines | 2 | - | 2 | - | 4 | 3 |
| 4 | PCC | U24EE414X | Any other course approved by BoS Chair and Dean AA | 2 | - | 2 | - | 4 | 3 |

**(OR)**

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

| **Exit Option to Qualify UG Diploma in EEE: Any Two (02) Skill based Courses -:** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S. No. | Category | Course Code | Course Title | L | T | P | O | E | C |
| 1 | SEC | U24SE411X | Electrical Estimation and Energy Auditing | - | - | 6 | - | 6 | 3 |
| 2 | SEC | U24SE412X | Programmable Logic Controller | - | - | 6 | - | 6 | 3 |
| 3 | SEC | U24SE413X | Electrical CAD (Computer-Aided Design) | - | - | 6 | - | 6 | 3 |
| 4 | SEC | U24SE414X | 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 their respective department during the summer vacation after IV Semester.

# CONTROL SYSTEMS ENGINEERING

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE401** | **Credits:** | **4** |
| **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**: 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**: design 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 & 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) on the 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 on Control Engineering by Prof. Ramkrishna Pasumarthy, Professor of EED, IIT Madras.*

| Course Articulation Matrix (CAM): | | U24EE401 CONTROL SYSTEMS ENGINEERING | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | U24EE401.1 | 2 | 2 | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO2 | U24EE401.2 | 2 | 2 | - | 1 | - | - | - | - | - | - | 1 | 2 | 1 |
| CO3 | U24EE401.3 | 2 | 2 | - | 1 | 1 | - | - | 1 | - | - | 1 | 2 | 1 |
| CO4 | U24EE401.4 | 2 | 2 | - | 1 | - | - | - | 1 | - | - | 1 | 2 | 1 |
| U24EE401 | | 2 | 2 | - | 1 | 1 | - | - | 1 | - | - | 1 | 2 | 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 | SDG 9: | Industry, Innovation and Infrastructure | This unit develops a strong theoretical foundation in control system modelling and analysis, enabling students to solve engineering problems systematically. Mathematical modelling and system representation are fundamental for designing modern industrial automation and smart engineering systems, thereby supporting innovation and quality technical education. |
| CO2 | determine the time-domain specifications of first & second-order systems and compare the performance of P, PI, PD and PID controllers | SDG 7 | Affordable and Clean Energy | Control components and controller design improve the efficiency, precision, and reliability of industrial automation, robotics, and energy systems. Proper controller tuning minimizes energy losses and enhances the performance of electrical drives and renewable energy applications, contributing to sustainable industrial development and energy efficiency. |
| CO3 | assess system stability in both time and frequency domains | SDG 11 | Sustainable Cities and Communities | Stability and frequency response analysis ensure the safe, reliable, and efficient operation of engineering systems such as power systems, transportation, manufacturing, and communication networks. MATLAB-based analysis promotes modern engineering practices essential for developing resilient and sustainable infrastructure. |
| CO4 | design the state-space | SDG 7 | Affordable | State-space methods and |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement** *The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | model of a given physical system and explore the fundamental concepts of compensators | | and Clean Energy, | compensation techniques enable the design of advanced control systems used in smart grids, autonomous systems, aerospace, and industrial automation. These concepts improve system performance, energy efficiency, and innovation while strengthening students' analytical and problem-solving skills for sustainable engineering solutions. |

# AC MACHINES

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE402** | **Credits:** | **4** |
| **Hours/Week (L-T-P-E):** | **2-1-0-3** | **CIE Marks:** | **60 %** |
| **Total Number of Teaching Hours:** | **60 Hrs** | **ESE Marks:** | **40 %** |

**Course Learning Outcomes (COs):**

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

**CO1**: compare Direct online (DOL), Star- Delta (γ-Δ), Autotransformer and Rotor resistance starting of 3-phase induction motor; Compare the speed control methods of 3-phase induction motors

**CO2**: choose the best motor for a given application by comparing the performance of various fractional kilowatt motors and evaluating the equivalent circuit parameters of a 1-Φ induction motor from the no-load and blocked rotor tests

**CO3**: evaluate the voltage regulation of 3-Φ Synchronous Generators through EMF, MMF and ZPF methods; analyse the phasor diagrams of salient pole and cylindrical rotor synchronous generators under different load conditions; evaluate the load shared among the parallel operated synchronous generators

**CO4**: compare the starting methods of 3-Φ Synchronous motors; analyse the excitation and power circles of synchronous motors and hence evaluate the operating points of 3-Φ Synchronous machines; design the rating of 3-Φ Synchronous motors for power factor correction

| **UNIT-I** | **9 Hrs** |
|---|---|

**3-Φ Induction Motors:** Construction details, Types, Production of rotating magnetic field, Principle of operation, Equivalent circuit, Phasor diagram, Torque equation, Slip torque characteristics, effects & change in supply voltage and frequency on torque and speed, Losses and efficiency, Determination of equivalent circuit parameters by no load and blocked rotor tests

**Methods of Starting & Speed Control:** Direct online (DOL), Star- Delta (γ-Δ), Autotransformer, Rotor resistance starters, Pole changing, variable frequency variable voltage, Rotor resistance

| **UNIT-II** | **9 Hrs** |
|---|---|

**1-Phase Induction Motors:** Principle &operation, Double field revolving theory, Methods of starting Split Phase Induction Motors (Resistor spilt phase, Capacitor start motor Capacitors start and run motor) Shaded pole motor Reluctance start motor, Equivalent circuit, Determination of equivalent circuit parameters by conducting no-load & blocked rotor tests

**Universal Motor:** Constructional features. Working principle, Characteristics and applications of universal motor

| **UNIT-III** | **9 Hrs** |
|---|---|

**3-Φ Synchronous Generators:** Cylindrical rotor machines: Construction, Types, Winding factors, Production of emf, Harmonics, Armature reaction, Synchronous reactance, Phasor diagrams, Load characteristics OC & SC tests, Methods of predetermination of voltage regulation by synchronous impedance (EMF), MMF and Potier triangle (ZPF) methods

**Salient pole machines:** Two-reaction theory and phasor diagrams. Slip test. Power angle characteristics

Synchronization & synchronizing power, Parallel operation and load sharing, operation on infinite bus bar, applications

| **UNIT-IV** | **9 Hrs** |
|---|---|

**3-Φ Synchronous Motors:** Principle of operation, No load and Load operation, Phasor diagrams, Methods of starting of 3-Φ synchronous motors, Effect of Excitation and power factor control, Hunting and its applications

**V and Inverted V Curves:** Excitation circles and power circles, Power factor correction using 3-Φ synchronous motors, Synchronous condenser, Applications

**Text Books:**

1. Bimbhra P.S., *Electric Machinery*, Khanna Publisher, 7th ed, 2014

**Reference Books:**

1. Bimbhra P.S., *Generalized Machine Theory*, Khanna Publisher, 5th ed, 2014
2. Chakrabarthy, *Electric Machines*, McGraw Hill, Publications, 2015
3. A.E. Fitzgerald, Kingsly, Stephen., *Electric Machinery*, Tata McGraw Hill, 2015
4. Stephen J.Chapman *Electric Machinery Fundamentals*, Tata McGraw Hill, 4th ed, 2015
5. Nagrath and Kotari, Electrical Machines‖ Tata McGraw Hill, 4th ed, 2004.

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

1.*NPTEL :: Electrical Engineering - NOC:Electrical Machines - II*
2.*NPTEL :: Electrical Engineering - NOC:Electrical Machines - I*

| **Course Articulation Matrix (CAM):** | | **U24EE402 AC MACHINES** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE402.1** | 2 | 2 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| **CO2** | **U24EE402.2** | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| **CO3** | **U24EE402.3** | 2 | 2 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| **CO4** | **U24EE402.4** | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| **3 – HIGH, 2 – MEDIUM, 1 – LOW** | | | | | | | | | | | | | | |

| **CO–SDG Alignment Matrix** | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | Compare Direct Online (DOL), Star-Delta, Autotransformer and Rotor Resistance starting methods of 3-phase induction motors; compare the speed control methods of 3-phase induction motors. | SDG7 | Affordable and Clean Energy | Efficient starting and speed control techniques of induction motors improve energy utilization, reduce power losses, and support reliable and sustainable electrical energy systems. |
| CO2 | Choose the best motor for a given application by comparing the performance of various fractional kilowatt motors and evaluating the equivalent circuit parameters of a single-phase induction motor. | SDG9 | Industry, Innovation and Infrastructure | Selection and performance evaluation of electrical machines support the development of reliable industrial systems and efficient electrical infrastructure for various engineering applications. |
| CO3 | Evaluate the voltage regulation of three-phase synchronous generators, analyse their performance under different load conditions and evaluate load sharing during parallel operation. | SDG7 | Affordable and Clean Energy | Performance evaluation of synchronous generators enhances efficient power generation, voltage regulation, and reliable operation of electrical power systems, contributing to sustainable energy generation. |
| CO4 | Compare the starting methods of three-phase synchronous motors, analyse excitation and power circles, and design synchronous motor ratings for power factor correction. | SDG12 | Responsible Consumption and Production | Power factor correction and optimum operation of synchronous motors improve energy efficiency, minimize reactive power demand, and promote responsible utilization of electrical energy resources. |

# SIGNALS AND SYSTEMS

| | | | |
|---|---|---|---|
| **Class:** B. Tech. IV -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE403-R25** | **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:** Represent and classify continuous and discrete time signals and analyze the properties of LTI and causal systems using signal operations and convolution techniques.

**CO2:** Analyze periodic and non-periodic signals using Fourier Series and Fourier Transform techniques for frequency domain representation and applications.

**CO3:** Apply sampling theorem, Laplace Transform and Z-Transform techniques for analysis of continuous-time and discrete-time systems.

**CO4:** Compute RMS values, average values and power associated with various periodic waveforms for engineering applications.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to signals:** Introduction to continuous-time and discrete-time signals. Classification of signals**:** periodic, aperiodic, energy and power signals. Elementary signals**:** unit step, ramp, impulse, exponential and sinusoidal signals, Representation of continuous and discrete time signals, Time shifting, time scaling and amplitude scaling properties.

**Introduction to systems:** Properties of systems: linearity, time invariance, causality, stability and memory, Linear Time Invariant (LTI) systems, Convolution for continuous and discrete time systems.

| **UNIT-II** | 9 **Hrs** |
|---|---|

**Fourier Series:** Fourier Series representation of continuous-time periodic signals, Trigonometric and exponential Fourier Series, Fourier Series representation of discrete-time periodic signals, Properties of Fourier Series

**Fourier Transform**: Fourier Transform for continuous-time signals, Properties and applications of Continuous-Time Fourier Transform (CTFT), Discrete-Time Fourier Transform (DTFT) and its applications, Frequency spectrum analysis of signals.

| **UNIT-III** | 9 **Hrs** |
|---|---|

**Sampling and Transform Techniques:** Sampling theorem and reconstruction of signals, Nyquist sampling criterion, Aliasing and anti-aliasing concepts.

**Laplace & Z-Transforms:** definition, properties and region of convergence, Inverse Laplace Transform Applications of Laplace Transform in system analysis, Z-Transform: definition, properties and region of convergence, Inverse Z-Transform and applications in discrete-time system analysis.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Periodic Waveform Analysis:** Definition and characteristics of periodic waveforms, Average value calculation of general periodic waveforms, RMS value calculation of periodic waveforms, Form factor and peak factor, Analysis of sinusoidal, square, triangular and rectified waveforms, Power computation in periodic signals, Applications in electrical and electronic circuits, Numerical problems on RMS and average value calculations.

**Textbook(s):**

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):** *https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee28*.

| **Course Articulation Matrix (CAM)** | | **U24EE403-R25 SIGNALS AND SYSTEMS** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PSO 1** | **PSO 2** |
| **CO1** | **U24EE403-R25.1** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 | 2 |
| **CO2** | **U24EE403-R25.2** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 | 2 |
| **CO3** | **U24EE403-R25.3** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 3 | 3 |
| **CO4** | **U24EE403-R25.4** | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | 2 | 3 |
| **U24EE403-R25** | | **2.75** | **3** | **1.75** | **1.75** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **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 | Represent and classify continuous and discrete time signals and analyze the properties of LTI and causal systems using signal operations and convolution techniques. | SDG 9 | Industry, Innovation and Infrastructure | Provides foundational knowledge for modern communication, automation, and intelligent infrastructure systems through signal and system analysis. |
| CO2 | Analyze periodic and non-periodic signals using Fourier Series and Fourier Transform techniques for frequency domain representation and applications. | SDG 11 | Sustainable Cities and Communities | Supports applications in smart communication, transportation, healthcare monitoring, and urban technological systems through signal processing techniques. |
| CO3 | Apply sampling theorem, Laplace Transform and Z-Transform techniques for analysis of continuous-time and discrete-time systems. | SDG 13 | Climate Action | Enables efficient monitoring, automation, and control systems used in environmental monitoring and climate-related engineering applications. |
| CO4 | Compute RMS values, average values and power associated with various periodic waveforms for engineering applications. | SDG 7 | Affordable and Clean Energy | Promotes efficient power analysis and energy utilization in electrical and electronic systems for sustainable engineering applications. |

# POWER SYSTEM GENERATION AND DISTRIBUTION

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE404** | **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 operation of fossil fuel-based and renewable generating stations.

CO2: analyse different types of tariffs in power system

CO3: determine distribution of voltage along the string insulators

CO4 : compare AC & DC distribution systems and calculate corona loss in a transmission system

| **UNIT-I** | **9 Hrs** |
|---|---|

**Generation of Electric Power Conventional Sources: :** The energy generation scenario in the global and Indian context, Hydroelectric Stations: – Types of hydroelectric plant – Principle of working– Layout of hydro power station: Steam power plant, Selection of site – Coal handling plant – Ash handling plant : Nuclear power plant: Types of reactors – Location of nuclear power plant

**Renewable energy Sources:** Introduction to renewable energy sources, Solar Energy, Wind Energy

| **UNIT-II** | **9 Hrs** |
|---|---|

**Economics of Generation:** Introduction, Definitions of connected load, Maximum demand, Demand factor, Load factor, Diversity factor, Load duration curve, Number and size of generator units, Base load and peak load plants, Cost of electrical energy-Fixed cost, Running cost & Tariff

| **UNIT-III** | **9 Hrs** |
|---|---|

**Insulators**: Types, Potential distribution over a string of suspension insulators, Factors affecting the distribution of voltage along the string insulators, Methods of equalizing potential string efficiency, Stringing charts

Transmission line sag calculation: The catenary curve, Sag tension calculations, Supports at different levels, Sag template

**Under Ground cables:** Electric stress in a cable, Grading of cables, Cable capacitance, Cable inductance, Dielectric loss and heating

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Distribution Lines**: Distribution systems, DC two wire and three wire systems. Single phase and three phase 3-wire and 4-wire AC systems – Comparison of efficiency, Kelvin's law – Economic size of conductor

**Corona: Introduction, Disruptive critical voltage, Corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona**

**Textbook(s):**


1. M.V. Deshpande, Elements of Electrical Power Station Design, Third Edition, Wheeler Pub. 2010.
2. C.L. Wadhwa, Generation, Distribution & Utilization of Electrical Energy, New age International, 3rd., 2017, New delhi


**Reference Book(s):**


1. H. Cotton & H. Barber, The Transmission and Distribution of Electrical Energy., ELBS, B.I. Pub., , 3rd ed, 1985. NewDelhi.
2. D.P. Kothari and I.J. Nagrath, Power System Engineering-- Tata McGraw-Hill Pub. Co.,, 3rd ed., 2019. New Delhi
3. Ned Mohan, "Electric Power Systems", Wiley, 1st ed., 2014, NewDelhi
4. Syed A Nasar, "Electric Power Systems", Mcgraw-Hill, 1st ed, 2006, Newdelhi.
5. S.N. Singh "Electric Power Generation, Transmission & Distribution", PHI, 2nd ed., 2009, New delhi


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

1. *NPTEL :: Electrical Engineering-Power System Generation, Transmission and Distribution (Encapsulated from earlier Video)*

2. *NPTEL :: Electrical Engineering - NOC:Power System Engineering*.

| Course Articulation Matrix (CAM): | | U24EE404 POWER SYSTEM GENERATION & DISTRIBUTION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE 404.1 | 3 | 2 | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| CO2 | U24EE 404.2 | 3 | 2 | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| CO3 | U24EE403.3 | 3 | 2 | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| CO4 | U24EE404.4 | 3 | 2 | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| **U24EE404** | | **3** | **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 | analyze the operation of fossil fuel-based and renewable generating stations. | SDG 7, 13 | Affordable & Clean Energy, Climate Action | This outcome evaluates the working principles and layouts of both conventional and non-conventional generation stations, which directly supports SDG7 &13 |
| CO2 | analyse different types of tariffs in power system | SDG7,12 | Affordable and Clean Energy , Responsible Consumption & Production | Designing multi-tier tariff structures acts as an economic tool to incentivize consumers towards demanded-side management (DSM) and energy conservation, minimizing resource wastage |
| CO3 | determine distribution of voltage along the string insulators | SDG 9 | Industry, Innovation, & Infrastructure | Optimizing structural distribution parameters prevents catastrophic grid flashovers and line failures, directly advancing to build resilient, reliable, and sustainable grid infrastructure |
| CO4 | compare AC & DC distribution systems and calculate corona loss in a transmission system | SDG 7 | Affordable and Clean Energy | Quantifying power dissipation via disruptive critical voltages and corona phenomena allows engineers to implement loss-reduction methodologies minimizing transmission line waste helps maximize overall grid efficiency. |

# PYTHON PROGRAMMING

| | | | |
|---|---|---|---|
| **Class:** B. Tech. IV – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE405** | **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 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, 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*, 1st ed. 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):**

https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Introduction to Machine Learning by Prof. Sudeshna Sarkar, Professor of CSE, IIT Kharagpur.*

https://onlinecourses.nptel.ac.in/noc23_cs99/ *NPTEL Video Lecture on Python For Data Science by By Prof. Ragunathan Rengasamy, IIT Madras.*

https://onlinecourses.nptel.ac.in/noc25_cs17 *NPTEL Video Lecture on Data Analytics with Python By Prof. A Ramesh, IIT Roorkee.*

https://onlinecourses.nptel.ac.in/noc25_cs69/ *NPTEL Video Lecture on The Joy of Computing using Python By Prof. Sudarshan Iyengar , IIT Ropar*

| **Course Articulation Matrix (CAM):** | | **U24EE405 : PYTHON PROGRAMMING** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE405.1** | 1 | 2 | 2 | 2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 2 |
| **CO2** | **U24EE405.2** | 2 | 2 | 2 | 2 | 2 | 1 | - | - | - | 1 | 1 | 2 | 2 |
| **CO3** | **U24EE405.3** | 2 | 2 | 2 | 2 | 3 | 1 | - | - | - | 1 | 1 | 2 | 2 |
| **CO4** | **U24EE405.4** | 2 | 2 | 2 | 2 | 3 | 1 | - | - | - | 1 | 1 | 2 | 2 |
| **U24EE405** | | 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. | SDG4 | Quality Education | Python programming develops computational thinking, algorithmic problem-solving, and programming skills, strengthening the digital competencies required for quality engineering education. |
| CO2 | apply collections, namespaces, packages, strings and regular expressions in application development. | SDG9 | Industry, Innovation and Infrastructure | Python modules, packages, data structures, and regular expressions enable the development of structured software solutions that support industrial automation, digital technologies, and innovative engineering applications. |
| CO3 | apply object-oriented programming principles in real-time problem solving. | SDG11 | Sustainable Cities and Communities | Object-oriented programming promotes the development of modular, reusable, and maintainable software systems that support smart infrastructure, industrial automation, and intelligent engineering applications contributing to sustainable communities. |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO4 | develop visualization graphs with Matplotlib and apply Numpy and Pandas libraries for data analysis | SDG13 | Climate Action | NumPy, Pandas, and Matplotlib facilitate data analysis and visualization for engineering applications such as energy monitoring, renewable energy systems, and performance analysis, enabling data-driven decisions that support sustainable engineering and climate action. |

# SOFT AND INTERPERSONAL SKILLS LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV Semesters | | **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):**

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

**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** | | |
| 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 | deliver concise & effective self-introduction and demonstrate confidence, spontaneous speaking skills within a limited time | SDG 4 | Quality Education | This aligns with SDG-4 as it focuses on developing communication skills, confidence and spontaneous speaking ability along with delivering a concise and effective self-introduction in a time-bound manner, which are essential for effective learning and employability |
| CO2 | conduct a personal SWOT analysis to identify areas for self-improvement and career development | SDG 4 | Quality Education | This aligns with SDG-4 as it encourages self-awareness and lifelong learning through personal SWOT analysis, enabling learners to identify strengths, weaknesses, opportunities, and threats 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 | SDG 4 | Quality Education | This aligns with SDG-4 as it develops communication, leadership, teamwork and interpersonal skills through active participation in group discussions, collaborative tasks and mock interviews, enhancing learners' overall competence and employability |
| 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 4 | Quality Education | This aligns with SDG-4 as it enhances learners' professional, digital and communication competencies through the creation of a resume, development of a LinkedIn profile, effective video-based communication and practice of email and workplace etiquette, thereby strengthening employability and career readiness |

# CONTROL SYSTEMS ENGINEERING LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE408** | **Credits:** | **3** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 time response specifications of uncontrolled and controlled second order systems & plot the characteristics of synchros

**CO2**: determine the transfer function of lag-lead compensators and DC and AC servo motor & visualize their characteristics

**CO3**: analyze the stability of LTI systems using MATLAB

**CO4**: determine controllability & observability of a given LTI system using MATLAB

**LABORATORY EXPERIMENTS**

**List of Experiments**

1. Determination of time domain specifications of uncontrolled second order system.
2. Effect of P, PI, PD, and PID Controllers on a System's Performance
3. Study of characteristics of Synchro Transmitter-Receiver pair
4. Analysis of Lag and lead compensation with reference to Magnitude and phase plot
5. Determination of transfer function of a DC servo motor
6. Stability analysis through Root Locus plot of L.T.I. system using MATLAB
7. Stability analysis through Bode plot of L.T.I. system using MATLAB
8. Stability analysis through Nyquist criteria using MATLAB
9. Verification of Controllability & Observability of L.T.I system using MATLAB
10. Linear system analysis (Time domain analysis, Error analysis) using MATLAB
11. Study of characteristics of AC servomotor
12. Mathematical modelling of DC motor and its experimental validation.

**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 on Control Engineering by Prof. Ramkrishna Pasumarthy, Professor of EED, IIT Madras.*

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

*Control Systems Engineering Laboratory Manual,* Department of EEE, KITSW.

| Course Articulation Matrix (CAM): | | U24EE408 CONTROL SYSTEMS ENGINEERING LABPRATORY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | U24EE408.1 | 2 | - | - | - | - | - | - | 2 | 2 | - | 1 | 2 | - |
| CO2 | U24EE408.2 | 2 | - | - | - | - | - | - | 2 | 2 | - | 1 | 2 | - |
| CO3 | U24EE408.3 | 2 | 1 | - | - | 2 | - | - | 2 | 2 | - | 1 | 1 | - |
| CO4 | U24EE408.4 | 2 | 1 | - | - | 2 | - | - | 2 | 2 | - | 1 | 1 | - |
| U24EE408 | | 2 | 1.67 | - | 1 | 1.67 | - | - | 1.67 | 2 | - | 1 | 1.75 | 1.00 |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| CO | CO Statement<br>*The student should be able to* | Relevant SDG | SDG Description | Mapping Justification |
| CO1 | analyze the time response specifications of uncontrolled and controlled second order systems & plot the characteristics of synchros | SDG4 | Quality Education | Students acquire analytical skills to evaluate the dynamic performance of control systems and electromechanical devices. This knowledge forms the basis for designing reliable automation and industrial control systems while strengthening engineering education and innovation |
| CO2 | determine the transfer function of lag-lead compensators and DC and AC servo motor & visualize their characteristics | SDG9 | Industry, Innovation and Infrastructure | Designing compensators and modelling servo motors improve system performance, precision, and energy efficiency in industrial automation, robotics, and electrical drive systems. These competencies support sustainable industrial development and efficient energy utilization. |
| CO3 | analyze the stability of LTI systems using MATLAB | SDG11 | Sustainable Cities and Communities | MATLAB-based stability analysis enables the design and validation of safe, reliable, and efficient control systems used in transportation, manufacturing, smart grids, and other critical infrastructure, contributing to resilient and sustainable communities. |
| CO4 | determine controllability & observability of a given LTI system using MATLAB | SDG9 | Industry, Innovation and Infrastructure | Understanding controllability and observability equips students with advanced system analysis and design skills required for modern control applications such as autonomous systems, aerospace, smart manufacturing, and intelligent infrastructure, promoting innovation and high-quality engineering education. |

# ELECTRICAL MACHINES LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. IV – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE409** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-0** | **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 :** determine the performance of 3-phase induction motor and implement methods for speed control

**CO2 :** determine the voltage regulation of 3-phasesynchronous generator using EMF, MMF, ZPF & direct loading methods

**CO3 :** determine the performance of 3-phasesynchronous motor using V- & inverted-V curves

**CO4 :** determine the performance of 1-phase induction motor

1. Determination of equivalent circuit parameters of a 3-Φ induction motor by No-load and Blocked rotor tests
2. Brake test on 3-phase Induction motor
3. Speed control of 3-Φ Induction motor by pole changing method
4. Predetermination of regulation of 3-Φ synchronous generator by E.M.F method
5. Predetermination of regulation of 3-Φ synchronous generator by M.M.F method
6. Determination regulation of 3-Φ synchronous generator by Z.P.F. method
7. Determination of $X_d$ and $X_q$ of a Salient Pole 3-Φ synchronous machine from slip test
8. Determination of V and inverted V curves of 3-Φ synchronous Motors
9. Determination of equivalent circuit parameters of 1-Φ Induction motor
10. Load test on capacitor start and run 1-Φ Induction motor

**Textbook(s):**

1. S.G. Tarnekar, P.K. Kharbanda —Laboratory Courses in Electrical Engineering, S.*Chand& Company Limited*, 4/e, 2003.

**Reference Book(S):**

1. P.S.Bhimbra, Electrical Machinery, Khanna publications, New Delhi, fully revised edition,2021

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

1. https://www.youtube.com/watch?v=GmuCJqNhxjk&list=PLL6ODihR1i4MYOzvUQUFMiH2h3KU5mgjL

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

Manual for —Electrical Machines- I *Laboratory* prepared by the Department of EEE

| **Course Articulation Matrix (CAM):** | | **U24EE409 ELECTRICAL MACHINES 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 | U24EE409.1 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 2 | 2 | - | 2 | 1 |
| CO2 | U24EE409.2 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 2 | 2 | - | 2 | 2 |
| CO3 | U24EE409.3 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 2 | 2 | - | 2 | 1 |
| CO4 | U24EE409.4 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 2 | 2 | - | 2 | 2 |
| **U24EE409** | | **2** | **2** | **1** | **1** | **1** | **-** | **-** | **1** | **2** | **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 | determine the performance of 3-phaseinduction motor and implement methods for speed control | SDG 7 | Affordable and Clean Energy | Efficient operation and speed control of induction motors help in reducing energy consumption and improving energy efficiency in electrical systems. |
| CO2 | determine the voltage regulation of 3-phasesynchronous generator using EMF, MMF, ZPF & direct loading methods | SDG 9 | Industry, Innovation and Infrastructure | Voltage regulation studies enhance the reliability and stability of power generation systems, supporting modern industrial infrastructure and innovation. |
| CO3 | determine the performance of 3-phasesynchronous motor using V- & inverted-V curves | SDG 12 | Responsible Consumption and Production | Performance analysis of synchronous motors enables optimal power factor operation and efficient utilization of electrical energy resources |
| CO4 | determine the performance of 1-phase induction motor | SDG 11 | Sustainable Cities and Communities | Understanding the operation and efficiency of single-phase induction motors supports sustainable residential and community-based electrical applications. |

# PYTHON PROGRAMMING LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. IV – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE410** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 :** 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)<br>5. Develop a Python program to demonstrate regular expression functions<br>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<br>2. Develop a Python program to demonstrate tuple and related functions<br>3. Develop a Python program to demonstrate set and related functions<br>4. Develop a Python program to demonstrate dictionaries<br>5. Develop a Python program to demonstrate comprehensions<br>6. Develop a Python program to demonstrate high order functions |
| **Experiment-7** |
| 1. Develop a python program to demonstrate classes and objects<br>2. Develop a python program to demonstrate class method<br>3. Develop a python program to demonstrate static method<br>4. Develop a python program to demonstrate inheritance<br>5. Develop a python program to demonstrate polymorphism<br>6. Develop a python program to demonstrate magic methods. |
| **Experiment-8 (UNIT-III)** |
| 1. Develop a python program to demonstrate multiple exception handling<br>2. Develop a python program to demonstrate multiple exception rising<br>3. Develop a python program to demonstrate multiple finally block<br>4. Develop a python program to demonstrate Assertions<br>5. Develop a python program on file operations for the following<br>a. To open and read data from a file<br>b. To write data into a file<br>c. To compute number of characters, words, lines in a file |
| **Experiment-9 (UNIT-III)** |
| 1. Develop a python programs to implement database connectivity<br>a. Install and verify SQLite Connector for Python<br>b. To connect check SQLite Database connectivity<br>c. To retrieve and display data from a table<br>d. To insert data into a table<br>e. To delete rows in a table |
| **Experiment-10** |
| 1. Develop a Python program to demonstrate NumPy array<br>2. Develop a Python program to demonstrate Slice operation<br>3. Develop a Python program to demonstrate Reshaping of an array<br>4. Develop a Python program to demonstrate Ufunctions<br>5. Develop a Python program to demonstrate Broadcasting of numpy arrays<br>6. Develop a Python program to demonstrate Aggregate operations |
| **Experiment-11 (UNIT-IV)** |
| 1. Develop a Python pandas program to create a series from a ndarray<br>2. Develop a Python pandas program to create a series from input files<br>3. Python pandas program to demonstrate indexing and slicing data frames<br>4. Develop a Python pandas program to demonstrate handling missing values<br>5. Develop a Python pandas program to demonstrate vectorized string operations,<br>6. Develop a Python pandas program to demonstrate handling time series data |
| **Experiment-12 (UNIT-IV)** |
| 1. Develop a Python program to draw a simple line plot<br>2. Develop a Python program to draw a scatter plots<br>3. Develop a Python program to draw a histogram plot<br>4. Develop a Python program to draw a binning and density<br>5. Develop a Python program to demonstrate a three dimensional plotting |

**Textbook(s):**

1. Reema Thareja, *Python Programming using problem solving approach*, 1st ed. 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

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

Python Programming Laboratory Manual, Department of EEE, KITSW

| **Course Articulation Matrix (CAM):** | | **U24EE410 : PYTHON PROGRAMMING LABORATORY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| CO1 | U24EE410.1 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO2 | U24EE410.2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO3 | U24EE410.3 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO4 | U24EE410.4 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| **U24EE410** | | **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 | Hands-on implementation and testing of Python programs develop computational thinking, logical reasoning, programming proficiency, and practical problem-solving skills, strengthening quality engineering education. |
| CO2 | implement and test python packages using string handling methods, regular expressions, and collections. | **SDG 9** | Industry, Innovation and Infrastructure | Practical implementation of Python modules, packages, string processing, regular expressions, and collections enables development of structured software solutions supporting industrial automation, digital technologies, and innovative engineering applications. |
| CO3 | implement and test object-oriented paradigms and database operations in | **SDG 9** | Industry, Innovation and | Practical implementation of object-oriented programming, file handling, exception handling, and |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | Python programming. | | Infrastructure | database connectivity develops software engineering skills required for reliable industrial applications and modern digital infrastructure. |
| CO4 | build visualization graphs with Matplotlib and adapt packages like Numpy, Pandas for data analysis. | **SDG 13** | Climate Action | Practical use of NumPy, Pandas, and Matplotlib enables engineering data analysis and visualization for applications such as energy monitoring, renewable energy systems, and environmental data analysis, supporting sustainable engineering and climate-informed decision making. |

# ENVIRONMENTAL STUDIES

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV Semester | | **Branch:** EEE | |
| **Course Code:** | **U24CY411** | **Credits:** | **0** |
| **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:** identify the natural resources and practice their usage more equitably

**CO2:** develop an action plan for sustainable alternatives and conserving 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** | **6 Hrs** |
|---|---|

**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

| **UNIT-II** | **6 Hrs** |
|---|---|

**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

| **UNIT-III** | **6 Hrs** |
|---|---|

**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

| **UNIT-IV** | **6 Hrs** |
|---|---|

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

Textbook(s):

1. Erach Bharucha, *Text Book of Environmental Studies for Under Graduate Courses,* 2nd Edn., Universities Press (India) Pvt. Ltd, 2013

**Reference Book(s):**

1. Y. Anjaneyulu, *Introduction to Environmental Science*, B.S. Publications, 2004.
2. Gilbert M. Masters, *Introduction to Environmental Engineering & Science*, 3rd Edn., Prentice Hall of India,1991
3. Anubha Kaushik, C.P. Kaushik, *Environmental Studies*, 4th Edn., New Age International

Publishers,2014
4. R. Rajagopalan, *Environmental Studies from crisis to cure*, Oxford University Press, 2nd Edn., 2011

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

https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/video lecture on renewable energy resources by Prof. Vaibhav. V. Goud and Dr. R. Anandalakshmi, Dept. Of Chemical Engineering, Guwahati.

| **Course Articulation Matrix (CAM):** | | **U24CY106 ENVIRONMENTAL STUDIES** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** | **U24CY106.1** | 2 | 1 | 2 | 1 | - | 2 | 1 | 1 | 1 | - | - | 1 | 1 |
| **CO2** | **U24CY106.2** | - | - | 2 | - | - | 1 | 1 | 1 | 1 | 1 | - | 1 | 1 |
| **CO3** | **U24CY106.3** | 1 | 2 | 1 | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **CO4** | **U24CY106.4** | - | - | 1 | - | - | 1 | 1 | 1 | 1 | - | 1 | 1 | 1 |
| **U24CY106** | | **1.5** | **1.5** | **1.5** | **1** | **-** | **1.25** | **1** | **1** | **1** | **1** | **1** | **1** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# WORKING, SERVICING, AND REPAIR OF ELECTRICAL APPLIANCES

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV -Semester | | **Branch:** EEE | |
| **Course Code:** | U24EE412X | **Credits:** | **3** |
| **Hours/Week (L-T-P-E):** | **2-0-2-4** | **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, (based on cognitive skills acquired from theory component)*

**CO1**: apply the electrical Codes, Standards and safety regulations

**CO2**: apply the basic electrical and electronics concepts

**CO3**: analyse the operational principles of electrical Instruments

**CO4**: identify the causes of faults and acquire skills for testing and repairing electrical appliances *(based on psychomotor skills acquired from laboratory component)*

**CO5**: interpret various component specifications used in power supply systems

**CO6**: evaluate the performance of various parts in household electrical appliances and suggest improvements.

**CO7**: evaluate the effectiveness of testing and repair techniques for electrical appliances

**CO8**: analyse the performance of electrical instruments

| **UNIT-I** | **4 Hrs** |
|---|---|

**Introduction to Electrical Codes and Standards:** Overview of electrical codes and their importance, Key organizations and standards (NEC, IEC, IEEE, NFPA) Comparison between NEC and IEC standards, NEC requirements for wiring, grounding, and protection, Updates and changes in the latest edition of the NEC, Electrical Safety and Regulations, Importance of electrical safety and regulations, and different electrical accessories like lamp holders, Various switches,
Sockets.

| **UNIT-II** | **4 Hrs** |
|---|---|

**Basic electrical and Electronics concepts and terminology:**

**Passive Components:** Resistor, Capacitor, Inductor, Connectors, Fuses- Circuit Symbol, Working principle, Types, Specification, Application.

**Active Components:** Diodes, BJT, SCR Circuit Symbol, Working principle, Specification, Application. **Batteries:** Battery Chemistry, Circuit Symbol, Working principle, Types and Specification. **Cables:** Twisted pair cable, Co-axial cable, fibre optic cable- Specification, Applications. **Switches:** Circuit
Symbol, Working principle, Types, specification, Application.

| **UNIT-III** | **4 Hrs** |
|---|---|

**Operational principles of various Electrical Instruments:** Working principle of MI and MC, Galvanometer, Voltmeter, Ammeter, Digital meter, Multimeter, Clamp meter, Safety equipment,
Tachometer, Earth resistance tester - Megger, Wattmeter, Energy meter.

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Testing and Repairs of Electrical Appliances:** Testing & control equipment - line tester, electronic line tester, series test lamp for single phase, parallel test lamp for single phase.
Principle, working, various parts and their use, types, specification, maintenance and troubleshooting of Tube Light, Electric Iron, Water Heater & Geyser, Room Heater, Hair dryer, Fan Regulator, Table lamp, Basic load calculations and circuit design, Inspection.

## LABORATORY COMPONENT

**List of Experiments**

1. Installation of a single-phase incoming supply system.
2. Testing & repairing of Tube -light, Torch, Table Lamp.
3. Study of Passive Components: Resistor, Capacitor, Inductor, Connectors, Cables & Fuses.
4. Study of Active Components: Diodes, BJT, Optocoupler, DIAC, TRIAC, SCR etc.
5. Installation and testing of earthing systems: Megger.
6. Study of transformer: Step –up, Step- down, Auto, with Center tap.
7. Installation and testing of circuit protection devices (Line tester MCBs, RCDs ELCB (Earth Leakage Circuit Breaker)
8. Study of Batteries: Physical (Solar & Thermal), Chemical (Fuel cell, Rechargeable, Non-Rechargeable)
9. Study of switches & Relays: Mechanical, Electronic & Electro-mechanical
10. Experimenting the Dismantling, reassembling, testing & repairs of Electric Iron

**Textbook(s):**

1. Vincent Del Toro, *Textbook of Principles of Electrical Engg*., Prentice Hall of India Pvt. Ltd., 2nd Edi, 1989, New Delhi.

**Reference Book(S):**

1. E. Fitzgerald, Arvin Grabel, David E. Higginbotham, *Textbook of Basic Electrical Engineering,* TMH Publishing Co., 2nd edition, 1981, USA.
2. Boylestad & Nashelsky, *Electronic Devices & Circuit Theory,* Pearson, 11th edition 2012, USA.

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

1. https://www.youtube.com/watch?v=2WanS_yo5oY, *YOUTUBE Video lecture on Basic*

Electronics Repair Course.

2. https://www.youtube.com/watch?v=jVFDcTCIetQ, *YOUTUBE Video lecture on* How to Repair LED Bulb at Home.

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

*Working, Servicing, And Repair of Electrical Appliances Lab Manual and Record Book (LMRB),* Department of EEE, KITSW

| Course Articulation Matrix (CAM): | | U24EE412X WORKING, SERVICING, AND REPAIR OF ELECTRICAL APPLIANCES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE412X.1 | 2 | 2 | 1 | 2 | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO2 | U24EE412X.2 | 2 | 2 | 1 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO3 | U24EE412X .3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO4 | U24EE412X.4 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO5 | U24EE412X.5 | 2 | 2 | 1 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO6 | U24EE412X.6 | 2 | 2 | 2 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO7 | U24EE412X.7 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO8 | U24EE412X.8 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **U24EE412X** | | **2.5** | **2.25** | **1.5** | **1.2** | **1** | **1** | **1** | **-** | **1** | **-** | **1** | **2** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# ELECTRICAL DESIGN, DRAWING AND ESTIMATION

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE413X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-E):** | **2-0-2-4** | **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, (based on cognitive skills acquired from theory component)*

**CO1**: apply the basics of electrical design, drawing conventions, and electrical symbols
**CO2**: develop electrical system designs for residential, commercial, and industrial installations
**CO3**: design the Orthographic projections of Simple Electrical Parts
**CO4**: analyse the Design/Drawing of application circuit used in an intelligent building *(based on psychomotor skills acquired from laboratory component)*
**CO5**: analyze the effectiveness of protection and safety systems in electrical installations
**CO6**: create electrical layout drawings and project documentation
**CO7**: evaluate electrical designs and installations for compliance with industry standards and safety codes
**CO8**: analyse real-world case studies and design electrical systems for various installations

| **UNIT-I** | **4 Hrs** |
|---|---|

**Symbols and Signs Conventions:**
Various Electrical Symbols used in Domestic and Industrial Installation and Power System as per BIS, understand and interpret engineering drawings.

| **UNIT-II** | **4 Hrs** |
|---|---|

**Panels/Distribution Boards:**
Design and drawing of panels/Distribution board using MCBs, main switches and change over switches for domestic and commercial installation.

| **UNIT-III** | **4 Hrs** |
|---|---|

**Orthographic projections of Simple Electrical Parts:** Pin type and shackle type insulator (Pin Type 11kV/66kV), Bobbins of a small transformer, Stay insulators/Suspension type insulators, Free hand sketching of M.C.B. and E.L.C.B Placed on Distribution Board.

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Design/Drawing of application circuit used in an intelligent building:** Stage lighting, Safety
system, Centralized air-conditioning system, Computer Networking.

**List of Experiments**

Electrical load calculation.
Preparation of single-line diagram.
Wiring of Fluorescent Lamp.
Wiring diagram for residential lighting installation.
Earthing and grounding system design.
Wiring of Lamps for stair case system.
Design of a Power Distribution Circuit.
Electrical System Protection Design.
Design and Calculation of Transformer Rating.
Designing of sub-Distribution panel.

**Textbook(s):**

**1.** Surjeet Singh, *Electrical Design and Drawing*, Dhanpat Rai & Co, 1st edition, 2001, New Delhi.

**Reference Book(S):**

**1.** Ankit Agarwal Madhvi Gupta, *Electrical Engineering Design, Drawing & Estimation,* S.K.

Kataria & Sons, 1st edition, 2017, New Delhi.

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

www. udemy.com - Udemy course on Electrical Designing & Drafting Course (Division 1) by Er. Sadiq Hussain.

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

*Electrical Design, Drawing and Estimation Lab Manual and Record Book (LMRB),* Department of EEE, KITSW.

| **Course Articulation Matrix (CAM):** | | **U24EE413X ELECTRICAL DESIGN, DRAWING AND ESTIMATION** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE413X.1** | 2 | 2 | 1 | 2 | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24EE413X.2** | 2 | 2 | 1 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO3** | **U24EE413X .3** | 3 | 3 | 2 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO4** | **U24EE413X.4** | 3 | 3 | 3 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO5** | **U24EE413X.5** | 2 | 2 | 1 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO6** | **U24EE413X.6** | 2 | 2 | 2 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO7** | **U24EE413X.7** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO8** | **U24EE413X.8** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **U24EE413X** | | **2.5** | **2.25** | **1.5** | **1.2** | **1** | **1** | **1** | **-** | **1** | **-** | **1** | **2** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

# TESTING AND MAINTENANCE OF DC MACHINES

| | | | |
|---|---|---|---|
| **Class:** B.Tech. IV -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE414X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-E):** | **2-0-2-4** | **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, (based on cognitive skills acquired from theory component)*

**CO1**: select appropriate safety terminology when addressing electrical hazards and accidents

**CO2**: design a comprehensive testing and maintenance procedure for electrical systems, based on ISS standards

**CO3**: develop a new maintenance procedure and testing plan for DC machines to improve performance

**CO4**: evaluate the suitability of DC machine foundation design and handling procedures for heavy equipment based on safety standards

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

**CO5**: analyse the construction of DC machines and develop magnetic curves

**CO6**: evaluate the performance characteristics of various types of DC generators

**CO7**: apply various speed control techniques in dc motors to plot the speed curve and testing of dc machines

**CO8**: analyse the performance characteristics of various types of DC motors

| **UNIT-I** | **4 Hrs** |
|---|---|

**Safety & Prevention of Accidents:** Introduction, Definition of terminology used in safety; safety, hazard, accident, major accident, responsibility, authority, accountability, monitoring, I.E. Act & statutory regulations for safety of persons & equipment working with electrical installation.

| **UNIT-II** | **4 Hrs** |
|---|---|

**General Introduction:** Introduction, Objectives of testing significance of I.S.S. concept of tolerance, routine tests, type tests, special tests, Methods of testing: a. Direct, b. Indirect, c. Regenerative, Concept of routine, preventive & breakdown maintenance.

| **UNIT-III** | **4 Hrs** |
|---|---|

**Testing of DC machines:**

**DC Generator Tests:** Characteristics of DC Generators

**DC Motor Tests:** Brake test, Speed control methods

**Advanced Tests:** Hopkinson's test and Retardation test

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Maintenance and Installation:** Factors involved in designing the DC machine foundation, Requirement of different dimensions of foundation for static machines, Use of various devices & tools in loading & unloading, lifting, carrying heavy equipment.

**List of Experiments**

1. Dismantle and reassemble a DC machine and identify parts.
2. Dismantle and reassemble various types of starters and identify parts.
3. Run a separately excited and self-excited DC generator at rated conditions and plot OCC, and identify critical speed and resistance. Deduce the same for different speeds.
4. Plot the efficiency curve of self and separately excited dc generators at rated condition.
5. Develop the internal and external characteristics of dc shunt generator at constant speed.
6. Plot efficiency curves of dc series generator at different loads.
7. Plot the efficiency curves of DC compound generator at different loads in (i) Long shunt configuration (ii) short shunt configuration
8. Choose the field control method to control the speed of the DC shunt motor and plot the field current v/s speed curve.
9. Apply Swinburne's test on a DC shunt machine to predetermine its efficiency (when working as a motor and generator)
10. Apply direct loading technique on a DC shunt motor to plot performance curves (torque Vs speed, output vs efficiency, speed and input current)

**Textbook(s):**

1. S. Rao, "*Testing Commissioning Operation & Maintenance of Electrical Equipment*", Khanna Publishers, 2nd edition, 2016, New Delhi.

**Reference Book(S):**

1. P. S. Bimbhra, *Electrical Machinery*, Khanna Publishers, 2nd edition, 2021, New Delhi.
2. Tarlok Singh, *Installation Commissioning & Maintenance of Electrical Equipments*, S. K. Kataria & Sons, 2nd edition, 2017, New Delhi.

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

1. https://www.youtube.com/watch?v=IoVF97M-be0&list=PLsGHIZ2Ko8OgTopXTlGg0C2I0JyQ1C-NJ, *YOUTUBE Video lecture on Testing and Commissioning of Electrical Equipments by JD'S Studies.*

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

*Electrical testing and maintenance of DC machine Lab Manual and Record Book (LMRB),* Department of EEE, KITSW

| **Course Articulation Matrix (CAM):** | | **U24EE414X TESTING AND MAINTENANCE OF DC MACHINES** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE414X.1** | 2 | 2 | 1 | 2 | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24EE414X.2** | 2 | 2 | 1 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO3** | **U24EE414X .3** | 3 | 3 | 2 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO4** | **U24EE414X.4** | 3 | 3 | 3 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO5** | **U24EE414X.5** | 2 | 2 | 1 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO6** | **U24EE414X.6** | 2 | 2 | 2 | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO7** | **U24EE414X.7** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO8** | **U24EE414X.8** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **U24EE414X** | | **2.5** | **2.25** | **1.5** | **1.2** | **1** | **1** | **1** | **-** | **1** | **-** | **1** | **2** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

## V SEMESTER

| S. No. | Category | Course Code | Course Title | Lectures / week | | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | C |
| 1 | OEC | U24OE501X-SE | Open Elective –SE (Pool - XV) | 2 | 1 | - | 3 | 3 |
| 2 | PCC | U24EE502 | Power Electronics | 2 | 1 | - | 3 | 3 |
| 3 | PCC | U24EE503 | Power System - II | 2 | 1 | - | 3 | 3 |
| 4 | PCC | U24EE504 | Microprocessors & Microcontrollers | 2 | 1 | - | 3 | 3 |
| 5 | PCC | U24EE505 | Utilization of Electric Energy | 2 | 1 | - | 3 | 3 |
| 6 | IKSC | U24IK506A | Universal Human Values - II | 2 | - | - | 2 | 2 |
| 7 | HSMC | U24MH507 | Technical English | - | - | 2 | 2 | 1 |
| 8 | PCC | U24EE508 | Power Electronics Laboratory | - | - | 2 | 2 | 1 |
| 9 | PCC | U24EE509 | Microprocessors & Microcontrollers Laboratory | - | - | 2 | 2 | 1 |
| 10 | ELC | U24EE510 | Seminar | - | - | 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-semBridge 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)** | | | | **NIL** | | | | |

| **Pool -XV**<br>**Startups & Entrepreneurship Basket (OE - S&EB)** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1. | **U24OE501A-SEB** | Design Thinking |
| 2. | **U24OE501B-SEB** | Innovative Product Design and Development |
| 3. | **U24OE501C-SEB** | Entrepreneurship |
| 4. | **U24OE501D-SEB** | Design Studio |
| 5. | **U24OE501Z-SEB** | 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 | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO 1 | U24OE501 A.1 | 2 | 2 | 1 | 1 | 1 | 1 | - | 1 | 1 | - | 1 | - | - |
| CO 2 | U24OE501 A.2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | - |
| CO 3 | U24OE501 A.3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | - |
| CO 4 | U24OE501 A.4 | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | - | - |
| **U24OE501A** | | **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** | identify customer segments and needs, assess customer-problem fit using Jobs-to-be-Done (JTBD) and customer persona frameworks | SDG 4 | Quality Education | Promotes creative learning, problem-solving, and innovation skills among students. |
| | | SDG 9 | Industry, Innovation and Infrastructure | Encourages innovative thinking for solving engineering and societal challenges. |
| **CO2** | analyze market opportunities and competitive dynamics, estimate business feasibility and build prototypes/MVPs for validating innovative solutions | SDG 3 | Good Health and Well-being | Human-centered design improves usability, safety, and user well-being. |
| | | SDG 11 | Sustainable Cities and Communities | Supports identification of sustainable and community-oriented solutions. |
| **CO3** | develop a Lean Canvas for a start-up venture by integrating value proposition, customer segments, revenue streams, key metrics and growth strategies | SDG 9 | Industry, Innovation and Infrastructure | Promotes innovation, product development, and technological advancement. |
| | | SDG 12 | Responsible Consumption and Production | Encourages efficient resource utilization and sustainable product development. |
| **CO4** | evaluate funding and team-building strategies and develop a scalable, investment-ready venture proposal through financial planning, validation and professional pitching | SDG 8 | Decent Work and Economic Growth | Supports entrepreneurship, innovation-driven business models, and employability skills. |
| | | SDG 9 | Industry, Innovation and Infrastructure | Encourages development of practical and scalable engineering solutions. |
| | | SDG 17 | Partnerships for the Goals | Promotes teamwork, interdisciplinary collaboration, and stakeholder interaction. |

# INNOVATIVE PRODUCT DESIGN & DEVELOPMENT

| | | | |
|---|---|---|---|
| **Class:** B. Tech. – V Semester | | **Branch:** Common to All | |
| **Course Code:** | **U24OE501B** | **Credits:** | **3** |
| **Hours/Week (L-T-P- E):** | **2-1-0-3** | **CIE:** | **60%** |
| **Total Number of Teaching Hours:** | **36 Hrs** | **ESE:** | **40%** |

**Course Learning Outcomes (COs)**

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

**CO1 :**create the systematic lifecycle of engineering design from customer requirements to technical specifications
**CO2 :**choose principles of industrial design, materials science, and ergonomics to optimize product usability
**CO3 :**implement the advanced rapid prototyping tools to compress the product development cycle
**CO4 :**design and build prototype performance using structural validation, risk analysis, and engineering metrics

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to product design engineering:** Translating user needs into Product Design Specifications (PDS); Quality Function Deployment (QFD) and the House of Quality framework; Functional decomposition and physical architecture mapping; Regulatory compliance, standards, and safety considerations in product architecture.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Principles of Industrial Design (ID):** Human-centered design and Ergonomics (Anthropometry); Visual hierarchy, form generation, and product aesthetics; Material selection frameworks (structural, thermal, electrical properties) and manufacturing process mapping (DFM/DFA: Design for Manufacturing and Assembly); Design semantics and user-interface touchpoints.

| **UNIT-III** | **9 Hrs** |
|---|---|

**Prototyping strategies: proof-of-concept vs. alpha/beta prototypes**: Additive manufacturing (3D Printing: FDM, SLA, SLS) and subtractive techniques (CNC machining); Rapid tooling, silicone molding, and vacuum forming; Digital prototyping: Computer-Aided Design (CAD) modeling, assembly verification, and finite element simulations; Virtual and Augmented Reality (VR/AR) workflows for product spatial validation.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Design of Experiments (DoE) for physical/digital prototypes**: Robust design testing and failure analysis; Cost modeling, Bill of Materials (BOM) management, and engineering change orders (ECO); Sustainable engineering: Design for Environment (DFE) and lifecycle evaluation; Preparing the product blueprint for production scaling and supply chain onboarding.

**Textbook(s):**


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


**Reference Book(S):**


1. Devdas Shetty, Product Design for Engineers, Cengage Learning, 9th Edn, 2015, Boston.
2. A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, PHI Learning, 2013, 13th Edn, New Delhi.
3. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education, 2001, New Delhi.
4. Benjamin W. Niebel and Alan B. Draper, Product Design & Process Engineering, McGraw-Hill, 1974, New York.
5. Paul Trott, Innovation Management and New Product Development, Pearson Education, 2016, Harlow.


**Web and Video link(s):** .
https://nptel.ac.in/courses/112107217; *NPTEL Video Lecture on Product Design and Development by Prof. Inderdeep Singh, Professor of Mechanical and Industrial Engineering, IIT Roorkee.*

| **Course Articulation Matrix (CAM):** | | **U24OE501B - Innovative Product Design & Development** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PS O1** | **PS O2** |
| **CO1** | **U24OE501B.1** | 2 | 2 | 1 | 1 | 1 | 1 | - | 1 | 1 | - | 1 | - | - |
| **CO2** | **U24OE501B.2** | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | - |
| **CO3** | **U24OE501B.3** | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | - |
| **CO4** | **U24OE501B.4** | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | - | - |

| 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** | **PO 10** | **PO 11** | **PS O1** | **PS O2** |
| **U24OE501B** | **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** | | | | | | | | | | | | | |

**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 using structural validation, risk analysis, and engineering metrics | SDG 8 | Decent Work and Economic Growth | Supports entrepreneurship, innovation-driven business models, and employability skills. |
| | | SDG 9 | Industry, Innovation and Infrastructure | Encourages development of practical and scalable engineering solutions. |
| | | SDG 17 | Partnerships for the 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 | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO 1 | U24OE501 C.1 | 2 | 2 | 1 | 1 | 1 | 1 | - | 1 | 1 | - | 1 | - | - |
| CO 2 | U24OE501 C.2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | - |
| CO 3 | U24OE501 C.3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | - |
| CO 4 | U24OE501 C.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 business modeling, unit economics, and venture monetization | SDG 9 | Industry, Innovation and Infrastructure | Strengthens innovation ecosystems by enabling the commercialization and scaling of technology-driven ventures. |
| | | SDG 12 | Responsible Consumption and Production | Encourages sustainable business practices by integrating resource efficiency, value creation, and responsible production principles into venture planning |
| **CO4** | build a clear roadmap for executing, legally | SDG 8 | Decent Work and Economic | Promotes entrepreneurship and job creation by enabling the successful |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement** *The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | safeguarding, and pitching a new venture | | Growth | 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:** | **U24OE505D** | **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): | | U24OE505D/U24OE605D - Design Studio | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PSO1 | PSO2 |
| CO1 | U24OE505D.1/U24OE605D.1 | 2 | 2 | 1 | 1 | 1 | 1 | - | 1 | 1 | - | 1 | - | - |
| CO2 | U24OE505D.2/U24OE605D.2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | - |
| CO3 | U24OE505D.3/U24OE605D.3 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | - |
| CO4 | U24OE505D.4/U24OE605D.4 | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | - | - |
| U24OE505D/U24OE605D | | 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** | 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 assumptions via stakeholder co-creation and design | SDG 8 | Decent Work and Economic Growth | Supports entrepreneurship, innovation-driven employment, and sustainable economic growth through market-oriented solution development. |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement** *The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | an institutional go-to-market plan. | 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. |

# POWER ELECTRONICS

| | | | |
|---|---|---|---|
| **Class:** B. Tech. V – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE502** | **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 :** select power semiconductor switching devices for a given application by understanding their characteristics and design snubber circuit in SCR based power converters

**CO2 :** analyze the performance of 1-phase, 3-phase controlled rectifiers and dual converters with R, R-L & R-L-E loads

**CO3 :** implement the commutation circuit in SCR based power converters and analyze voltage & current source inverter circuits and buck, boost, buck-boost DC-DC converters

**CO4 :** analyze the operating principle of 1-phase AC voltage controllers, 1-Φ to 1-Φ cycloconverters & applications of power electronics

| **UNIT-I** | **9 Hrs** |
|---|---|

**Characteristics of Power Semiconductor Devices:** Introduction of power semiconductor devices like power diode, SCR, GTO, MOSFET, IGBT and their characteristics Qualitative treatment of DIAC, TRAIC, SiC & GaN devices.

**Silicon Controlled Rectifier (SCR):** Two transistor analogy of SCR, gate triggering circuits, resistance, resistance–capacitance trigger circuits, UJT as relaxation oscillator, Protection of SCR against over voltages, over currents, voltage & current transients.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Phase Controlled Rectifiers:** Natural commutation, phase angle control - single phase & three phase - half wave, full wave, half controlled and fully controlled rectifiers - with and without freewheeling diodes for R, R-L and R-L-E loads, distortion factor and power factor calculation, effect of source inductance, Dual converters.

| **UNIT-III** | **9 Hrs** |
|---|---|

Forced commutation Techniques of SCR

**Choppers:** Basic circuit, Step-up& Step-down, Classification of choppers on the basis of various quadrants, DC-DC converters without electrical isolation: Buck, Boost, Buck-Boost (Continuous Conduction Mode only)**.**

**Inverters:** Voltage source inverters and Current source inverters, 1-phase and 3-Phase bridge inverters (180°, 120° conduction mode), Mc-Murray Bedford Inverter, Brief introduction to sinusoidal pulse width modulation of single-phase & three-phase VSI.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**AC Voltage Controllers:** Single Phase AC Controllers with R and RL loads Single Phase Cycloconverters: Principle and operation of centre tap and bridge type.

**Applications of Power Electronics Converters:** Battery charger, Uninterruptible power supply, Switched mode power supply: forward, flyback and push-pull converters (qualitative treatment only).

**Textbook(s):**

1. P.S. Bhimbra, *Power Electronics*, 6th ed., Khanna Publishers, 2016, New Delhi.

**Reference Book(S):**

1. M.D. Singh & K.B. Kanchandani, *Power Electronics*,., Tata McGraw Hill Education (India) Pvt. Ltd , 2nd ed , 2007. New Delhi.
2. Muhammad H. Rashid, *Power Electronics-Circuits, Devices and Applications*, Pearson, 2018, 4 th Edition, New Delhi.
3. P.C. Sen, *Power Electronics*,Tata McGraw Hill Education (India) Pvt. Ltd., 2013,New Delhi.
4. Ned Mohan, Tore M. Undeland, Robbins, *Power Electronics: Converters, Applications, and design*, 3rd ed., John Wiley & Sons, 2007, New Jersey.

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

1. https://nptel.ac.in/courses/108/101/108101038/

2. https://nptel.ac.in/courses/108/102/108102145/
3. https://nptel.ac.in/courses/108/101/108101126/

| Course Articulation Matrix (CAM): | | U24EE502 : POWER ELECTRONICS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE502.1 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | - | 1 | 3 | 2 |
| CO2 | U24EE502.2 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | 3 | 3 |
| CO3 | U24EE502.3 | 3 | 3 | 3 | 2 | 2 | - | - | - | - | - | 1 | 3 | 3 |
| CO4 | U24EE502.4 | 3 | 3 | 1 | 1 | 2 | - | - | - | - | - | 1 | 2 | 3 |
| **U24EE502** | | **3** | **2.75** | **1.75** | **1.5** | **2** | **-** | **-** | **-** | **-** | **-** | **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 | select switching devices for a given power converter and triggering methods & protection of SCR | SDG12 | Responsible Consumption and Production | Efficient power electronic devices help reduce energy losses and improve sustainable energy utilization. |
| CO2 | evaluate the performance of phase-controlled rectifiers | SDG9 | Industry, Innovation and Infrastructure | Performance evaluation of rectifiers supports industrial automation, reliable power systems, and modern electrical infrastructure. |
| CO3 | design DC-DC converter and Inverter for a given performance | SDG7 | Affordable and Clean Energy | DC-DC converters and inverters are essential in renewable energy systems, electric vehicles, solar PV systems, and efficient energy conversion |
| CO4 | analyse and evaluate the operation of Inverters and ac voltage controllers & power electronic applications in industry ac voltage controllers & power electronic applications in industry | SDG13 | Climate Action | Improved efficiency in industrial power electronic systems contributes to reduced carbon emissions and supports sustainable energy practices. |

| POWER SYSTEM -II | | | |
|---|---|---|---|
| **Class:** B. Tech. V – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE503** | **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 :** determine the efficiency & voltage regulation of transmission lines

**CO2 :** analyze different types of voltage control and compute per unit values in a power system.

**CO3 :** determine the fault currents for symmetrical and unsymmetrical faults

**CO4 :** analyze traveling wave phenomena in transmission lines and various methods of system neutral grounding

| UNIT-I | 9 Hrs |
|---|---|

**Performance of transmission line**: Representation of transmission lines, short transmission lines, medium length lines, Nominal T and ∏ representation, long transmission lines

**General network constants (A, B, C, D constants):** Cascaded &parallel networks, skin effect, proximity effect and Ferranti effect, surge impedance loading, power flow through transmission lines

| UNIT-II | 9 Hrs |
|---|---|

**Voltage control**: Introduction, methods of voltage control, shunt, series compensation, tap changing transformers, booster transformers, synchronous phase modifiers

**Per unit representation of Power systems**: Single line diagram, impedance and reactance diagrams, per unit quantities, advantages of per unit systems

| UNIT-III | 9 Hrs |
|---|---|

**Symmetrical components**: Significance of positive, negative, zero sequence components, average 3-phase power in terms of symmetrical components

**Symmetrical & Unsymmetrical fault analysis:** Sequence impedances and sequence networks for fault calculations, single line to ground (LG) fault, LL fault, LLG fault, LLL fault (without fault impedance), reactors and their location, short circuit capacity of a bus

| UNIT-IV | 9 Hrs |
|---|---|

**Traveling waves on transmission line**: Production of travelling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction coefficients at a T-junction, line terminated through a capacitance, attenuators of travelling waves.

**System neutral grounding:** Introduction, ungrounded neutral system, arcing grounds, advantages of neutral grounding, methods of neutral grounding solid grounding, reactance grounding, Peterson coil grounding, grounding transformer, choice of grounding

**Textbook(s):**


1. C.L. Wadhwa, Electrical Power Systems, New Age International Pvt. Ltd., 8th edition, 2022, New Delhi.


**Reference Book(S):**


1. Olle I Elgerd, Electric Energy Systems Theory, Tata McGraw Hill Education (India) Pvt. Ltd., 2011, New Delhi.
2. Stevenson W.D., Elements of Power System Analysis, McGraw Hill International Publishers, 4th edition, 2014, New York.
3. D.P. Kothari, I.J. Nagarath, & R Saket, Modern Power System Analysis, Tata McGraw Hill Education (India) Pvt. Ltd, 5th edition, 2022, New Delhi.
4. J. Grainger & W.D. Stevenson, Power System Analysis, Tata McGraw Hill Education (India) Pvt. Ltd., 2017, New Delhi.


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

Power System Analysis on SWAYAM-NPTEL by Prof. Debapriya Das (IIT Kharagpur), https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee169

https://nptel.ac.in/courses/108105067

| Course Articulation Matrix (CAM): | | U24EE503 : POWER SYSTEM-II | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE503.1 | 3 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | 1 | 3 | 2 |

| Course Articulation Matrix (CAM): | | U24EE503 : POWER SYSTEM-II | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO2 | U24EE503.2 | 3 | 3 | 2 | 2 | 1 | 2 | - | - | - | - | 1 | 3 | 2 |
| CO3 | U24EE503.3 | 3 | 3 | 2 | 2 | 1 | 3 | - | - | - | - | 1 | 3 | 3 |
| CO4 | U24EE503.4 | 3 | 3 | 2 | 2 | 1 | 3 | - | - | - | - | 1 | 3 | 3 |
| U24EE503 | | 3 | 3 | 2 | 2 | 1 | 2.5 | - | - | - | - | 1 | 3 | 2.5 |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| CO | CO Statement<br>*The student should be able to…* | Relevant SDG | SDG Description | Mapping Justification |
| CO1 | analyze the efficiency & voltage regulation of transmission lines | SDG 7 | Affordable & Clean Energy | Minimizing power transmission line losses directly raises overall system grid efficiency. It guarantees affordable energy distribution by decreasing fuel consumption and operational overhead |
| CO2 | evaluate different types of voltage control and compute per unit values in a power system | SDG 9 | Industry, Innovation, & Infrastructure | Implementing voltage control methods like shunt/series compensation provides grid stability and power quality. Per-unit computations enable standardized industrial simulation to successfully upgrade aging electrical grids |
| CO3 | determine the fault currents for symmetrical and unsymmetrical faults | SDG 9 | Industry, Innovation, & Infrastructure | Calculating exact fault currents allows engineers to correctly rate protective equipment like circuit breakers. This prevents major blackouts, secures industrial supply chain continuity, and strengthens energy infrastructure resilience |
| CO4 | analyze the concept of traveling waves on transmission line and specify types of system neutral grounding | SDG 11 | Sustainable Cities & Communities | Proper system neutral grounding limits hazardous arcing grounds and high overvoltage wave surges (p. 1). This safeguards electrical networks and drastically lowers fire hazards or safety risks to the public and utility personnel |

# MICROPROCESSORS AND MICROCONTROLLERS

| | | | |
|---|---|---|---|
| **Class:** B. Tech. V – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE504** | **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 architectural features, instruction execution cycle, timing requirements and interrupt structure of 8085 microprocessor.

**CO2 :** Apply the instruction set of 8085 microprocessors to develop assembly language programs for data manipulation, delay generation and subroutine implementation.

**CO3 :** analyze the memory organization, segmentation and addressing modes of 8086 microprocessor.

**CO4 :** Apply the concepts of 8051 microcontroller to develop interfacing programs for peripheral devices and real-time applications.

| UNIT-I | 9 Hrs |
|---|---|

**8085 Microprocessor:** Architecture, Registers, Flags, Pin configuration & function of each pin, timing diagrams - machine cycle fetch, Decode & Execute operations, Memory and I/O read and write cycles, WAIT state, interrupt timing diagram

| UNIT-II | 9 Hrs |
|---|---|

**Instruction Set and Programming:** Addressing modes of 8085, instruction set, data transfer, arithmetic, logical, rotate, branch and machine control instructions, simple assembly language programs, time delays, concept of stack & instruction related to stack, 8085 interrupts, RST, RIM, SIM instructions, Subroutines and Conditional call instructions

| UNIT-III | 9 Hrs |
|---|---|

**8086 Microprocessor:** Organization of 8086 CPU, Architecture, general purpose registers, segment registers, concept of memory segmentation, physical and logical addressing, addressing modes, pin diagram, minimum & maximum mode of operation, timing diagrams for I/O operations, procedures and macros

| UNIT-IV | 9 Hrs |
|---|---|

**8051 Microcontroller:** Architecture, instruction set, addressing modes, assembly language programming, timers, input-output ports, interrupts, serial ports, interfacing with LEDs, Switches & Stepper Motor, Real Time Clock (RTC)

**Textbook(s):**

1. Ramesh S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, 5th ed., 2000, Penram International, Mumbai. (*Chapters 1 to 9*)
2. Muhammed Ali Mazidi, *The 8051 Microcontrollers and Embedded systems using Assembly and C*, 2nd ed., 2006, Pearson, New Delhi. (*Chapters 1 to 6, 8 to 13*)

**Reference Book(S):**

1. Kenneth J Ayala, *8086 Microprocessor: Programming & Interfacing with PC*, 1st ed., 2007, Delmar Cengage Learning India, Noida, Uttar Pradesh.
2. A. K. Ray and K M Burchandi, *Advanced Microprocessors and Peripherals*, 3rd ed., 2013, Tata McGraw Hill, Delhi.
3. Kennet Ayala, *The 8051 Microcontroller: Architecture, Programming and Applications*, 2nd ed., 1996, Penram Publications, Mumbai.

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

https://onlinecourses.nptel.ac.in/noc23_ee47/preview; *NPTEL Video Course on Microprocessors and Microcontrollers by Prof. Santanu Chattopadhyay, Professor at Department of Electronics and Electrical Communication Engineering, IIT Kharagpur*.

| Course Articulation Matrix (CAM): | | U24EE504: MICROPROCESSORS AND MICROCONTROLLERS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE504.1 | 2 | - | 1 | - | - | - | - | - | - | - | 1 | 2 | - |
| CO2 | U24EE504.2 | 2 | 2 | 1 | 1 | 1 | - | - | - | - | - | 1 | 2 | 1 |
| CO3 | U24EE504.3 | 2 | - | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 |
| CO4 | U24EE504.4 | 2 | 2 | 2 | - | 1 | - | - | - | - | - | - | 1 | 2 |

| Course Articulation Matrix (CAM): | U24EE504: MICROPROCESSORS AND MICROCONTROLLERS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **U24EE504** | 1.75 | 2.0 | 2.0 | 1.25 | 1.0 | 1.0 | - | - | - | - | - | 1.0 | 1.5 |
| **3 – HIGH, 2 – MEDIUM, 1 - LOW** | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | discuss architectural features, pin configuration and timing diagrams of 8085 microprocessor | SDG 9 | Industry, Innovation and Infrastructure | Understanding microprocessor architecture is foundational for industrial automation and embedded system design, driving technological innovation. |
| CO2 | develop assembly language programs for data manipulation, subroutines, and delays using 8085 | SDG 4 | Quality Education | Assembly programming develops logical thinking and problem-solving skills essential for engineering education. |
| CO3 | discuss memory segmentation and addressing modes of 8086 microprocessor | SDG 9 | Industry, Innovation and Infrastructure | 8086 architecture concepts are critical for understanding modern computing systems used in industrial and infrastructure applications. |
| CO4 | develop interfacing programs for I/O devices with 8051 microcontrollers (LEDs, switches, stepper motor, RTC) | SDG 9 | Industry, Innovation and Infrastructure | Microcontroller interfacing skills enable smart device development, supporting industrial automation and infrastructure monitoring. |

# UTILIZATION OF ELECTRIC ENERGY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. V – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE505** | **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,*
*(based on cognitive skills acquired from theory component)*

**CO1 :** analyze electric traction systems and traction motor characteristics, and compute specific energy consumption for different speed-time curves.

**CO2 :** select suitable electric drives for industrial applications based on load characteristics and operating requirements

**CO3 :** design circular and ribbon type heating elements and analyze the operating characteristics of electric heating and welding techniques.

**CO4 :** design lighting schemes for a given surface, perform illumination calculations, and determine the required power factor correction for electrical systems

| **UNIT-I** | **9 Hrs** |
|---|---|

**Electric Traction:** Systems of electric traction, transmission of drive, mechanics of traction movement, trapezoidal and quadrilateral speed – time curves, tractive effort, power and energy output from driving axles, specific energy output, specific energy consumption, factors effecting the specific energy consumption and coefficient of adhesion, concept of average speed and schedule speed, Speed control methods of DC traction motors-rheostatic, field control, series-parallel method, Speed control methods of AC traction motors, shunt-bridge transition, Collection of current - third rail, overhead wires, pantograph

| **UNIT-II** | **9 Hrs** |
|---|---|

**Industrial Drives:** Introduction, factors governing selection of electric motors, nature of electric supply, types of drives, nature of loads, standard ratings of motors, choice of ratings of motors, types of motors used in industrial drives, cement manufacturing industries, textile mills, paper mills, ship propulsion drives

| **UNIT-III** | **9 Hrs** |
|---|---|

**Electric Heating:** Elementary principle of heat transfer, Stefan's law, types of electric furnaces, resistance furnace, design of heating element, losses and efficiency, construction and working of different types of induction furnaces – dielectric heating, arc furnaces

**Electric Welding:** Types of welding, resistance, gas and arc welding, characteristics of carbon and metal arc welding, comparison

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Illumination(qualitative treatment only):** Terminology, Laws of illumination, coefficient of utilisation and depreciation, polar curves, sources of light- fluorescent lamps, compact fluorescent lamps, LED lamps, discharge lamps, mercury vapour lamps, sodium vapour lamps and neon lamps, comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, types and design of lighting scheme, lighting calculations for a given surface, Factory lighting, street lighting and flood lighting

**Power Factor Correction:** Introduction, disadvantages of a low power factor, causes of low power factor, power factor improvement, economics of power factor improvement, most economical power factor when kW demand is constant, most economical power factor when kVA demand is constant

**Textbook(s):**


1. J.B. Gupta, *Utilization of Electric Power & Electric Traction*, S.K. Kataria& Sons, 10th edition, 2012, New Delhi.
2. C.L. Wadhwa, Generation Distribution and Utilization of Electrical Energy, 5th ed., New Age International Pvt. Ltd., 2015, New Delhi.


**Reference Book(S):**

1. E. Openshaw Taylor, *Utilization of Electric Energy*, Orient Longman private limited, 1st edition, 2006, Hyderabad.
2. R.K. Rajput, *Utilisation of Electrical Power*, 2nd ed., Laxmi Publications, 2016, New Delhi.

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

ps://www.youtube.com/watch?v=nMT7MzmG5ZA&list=PLs5_Rtf2P2r7JiPm-TDQ75WYxzMgqm_jk; *NPTEL Video Lecture on Utilization of Electrical Energy by Mr. Rahul Sharma, GATE – EE Expert, Unacademy.*

| **Course Articulation Matrix (CAM):** | | **U24EE505 : UTILIZATION OF ELECTRICAL ENERGY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE505.1** | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO2** | **U24EE505.2** | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO3** | **U24EE505.3** | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 | 1 | 2 |
| **CO4** | **U24EE505.4** | 2 | 2 | 2 | 2 | 2 | 2 | - | 2 | 2 | 2 | 2 | 1 | 2 |
| | **U24EE505** | 2 | **2** | **2** | **2** | 2 | **2** | **-** | **2** | **2** | **2** | **2** | **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 | analyse systems of electric traction, traction motors, and compute specific energy consumption for different speed-time curves | SDG11 | Sustainable Cities and Communities | Evaluates specific energy consumption (SEC) to lower urban transit carbon output, and targets clean, efficient city-wide public transport networks. |
| CO2 | identify suitable drives for industrial applications | SDG9 | Industry, Innovation and Infrastructure | Covers specialized industrial operations including paper, textile, and cement manufacturing. Optimizes electric motor drive configurations for heavy industrial machinery. |
| CO3 | design circular and ribbon type heating element and describe the welding techniques | SDG9 | Industry, Innovation and Infrastructure | Implements precise control via induction, arc, and dielectric heating methods. Minimizes manufacturing raw-material loss and thermal waste during processing. |
| CO4 | design of lighting scheme and lighting calculation for a given surface and determine the power correction for a typical system | SDG7 | Affordable and Clean Energy | Integrates energy-efficient light sources, including modern LED and fluorescent lamps, and enhances power factors to mitigate unnecessary transmission line power losses |

# UNIVERSAL HUMAN VALUES - II

**Class:** B. Tech. V Semester | **Branch:** ALL BRANCHES

| Course Code: | U24IK506A | Credits: | 1 |
|---|---|---|---|
| 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:** 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: Ek Parichaya*, Raipur: Jeevan Vidya Prakashan, Amarkantak, 2018.
2. A.N. Tripathi, *Human Values*, New Age International Publisher, 3rded., New Delhi, 2019.
3. M. Govindrajran, S. Natrajan & V.S. Senthil Kumar, *Engineering Ethics (includes Human Values)*, PHI Learning Pvt. Ltd., 12th ed., Haryana, 2011.
4. Jayshree Suresh, B. S. Raghavan, *Human Values & Professional Ethics*, 4thed., S. Chand & Co. Ltd., New Delhi, 2012.

**Additional Resources:**

1. A set of DVDs containing - Video of Teachers" Orientation Program - PPTs of Lectures and Practice Sessions (*Audio-visual material for use in the practice sessions*)

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

https://fdp-si.aicte-india.org/UHVII.php

| Course Articulation Matrix | | U24IK506A Universal Human Values - II | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24IK506A.1 | 2 | 1 | - | - | - | 1 | - | 3 | - | - | - | 1 | 1 |
| CO2 | U24IK506A.2 | - | 2 | - | - | - | 3 | - | 3 | 2 | 2 | - | - | 1 |
| CO3 | U24IK506A.3 | 1 | 2 | - | - | - | 2 | 3 | 2 | - | - | - | 1 | 1 |
| CO4 | U24IK506A.4 | 1 | 2 | - | - | - | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 1 |
| **U24IK506A** | | **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 | 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 | 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 | Enhances understanding of ecological balance, coexistence, environmental sustainability, and conservation. |
| 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 | Encourages ethical professional practices, sustainable technologies, and environmentally responsible production systems. |

# TECHNICAL ENGLISH

| | | | |
|---|---|---|---|
| **Class:** B. Tech. V Semesters | | **Branch:** Common to all Branches | |
| **Course Code:** | **U24MH507** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **CIE:** | **100** |
| **Total Number of Teaching Hours:** | **24 Hrs** | **ESE:** | **-** |

**Course Learning Outcomes (COs)**

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

**CO1 :** develop effective listening, speaking, reading and writing skills by understanding native-speaker conversations and expressing ideas clearly and confidently using appropriate vocabulary, while maintaining fluency, coherence and accurate pronunciation.

**CO2 :** enhance communication and professional writing skills through podcast comprehension, group discussions, resume and email writing

**CO3 :** develop the ability to understand reading texts, conversations of both native and non-native speakers, interpret visual information, and produce clear and well-structured technical reports.

**CO4 :** develop the ability to perform well in interviews and present effectively with clarity of speech and appropriate accent.

**Activity-1** **2 hrs**

**Phonetic Foundations, Authentic Audio-Visual Comprehension & Vocabulary Enhancement**: Speech Sounds- 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:** Word Formation- Prefixes-Suffixes.

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

**Activity - 2** **2 hrs**

**Story Narration, Writing Skills and Vocabulary Enhancement-** Narrative structure (beginning, build-up, climax, conclusion), Cohesive devices, Voice modulation & Expression. **Writing:** Principles of Paragraph Writing- Importance of Coherence in Writing- 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 - 3** **2 hrs**

**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** **2 hrs**

**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 -5** **2 hrs**

**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 interaction and word pair exercises |
| **Activity -6** **2 hrs** |
| **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.<br>**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 -7** **2 hrs** |
| **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<br>**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 -8** **2 hrs** |
| **Writing & Vocabulary Enhancement:** Professional Resume Writing techniques, Action verbs in resume writing, Letter of Application, E-mail Etiquette—vocabulary: Jumbled sentences<br>**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 -9** **2 hrs** |
| **Reading Comprehension, Newspaper Reading & Vocabulary Enhancement:** Intensive reading , Extensive reading, Newspaper reading:5W1H method, Summarization, vocabulary building<br>**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** **2 hrs** |
| **PowerPoint Presentations**: Concept and purpose of presentations, layout and structure (title, introduction–body–conclusion), slide design elements, visual aids, common mistakes to avoid<br>**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 |
| **Activity-11** **2 hrs** |
| **Essay Writing, Vocabulary Enhancement –** Concept and Types of Essays**,** Essay structure (introduction–body–conclusion), paragraph coherence, clarity and objectivity, Sentence completion with correct word/Group alternative word/group<br>**Activity:** Write essays on given topics focusing on structure, coherence, and clarity. Sentence completion practice exercises |
| **Activity-12** **2 hrs** |
| **Mock Interview – Technical & HR:** Introduction to mock interviews: Purpose and importance, types of interviews, interview etiquette, self-introduction, common HR questions, self-assessment<br>**Activity:** Mock interview with appropriate dress code. Record and review own performance, Feedback session |
| **Textbook(s):**<br>1. Arun Sharma & Meenakshi Upadhyay, "*Verbal Ability and Reading Comprehension for CAT & Other Management Examinations*", 8th Edition, McGraw Hill Education (India) Private Ltd, Chennai, 2018<br>**2.** Meenashki Raman & Sangeethe Sharma, "*Technical Communication: Principles and Practice,* 3rd Edition, New Delhi; New York: Oxford University Press,2004 |
| **Reference Book(S):**<br>1. Nishit K. Sinha, "Verbal Ability and Reading Comprehension for the CAT", 3rd |

Edition Pearson India Education Services Pvt. Ltd., Chennai
2. Harper Collins, "Collins COBUILD English Grammar" Third Edition, Harper Collins Publishers Ltd.
3. Jerald J. Alfred, Charles T. Brusaw and Walter E. Oliu," Handbook for Technical Writing"12th Edition, Macmillan
4. R.S. Agarwal, "A modern Approach to Verbal and Non-Verbal Reasoning" Revised edition 2025 , Chand Publishing, India.

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

1. Learn/Practice English with MOVIES (Lesson #1) Title: The Incredibles https://www.youtube.com/watch?v=5SfQhkMsUFk&list=PLA7lNLNvxTzig5dqfGl8DGbLOvUI08yXg&inde x=2
2. Learn English with WRECK-IT RALPH https://www.youtube.com/watch?v=wVhG59zh4uQ&list=PLA7lNLNvxTzig5dqfGl8DGbLOvUI08yXg&ind ex=4
3. The Pursuit of Happiness (2006): Most Powerful Moments! https://www.youtube.com/watch?v=TkD1QvjKlqU
4. **Podcast by** Raul John" Inside the Mind of India's AI Kid". Business Today https://www.youtube.com/watch?v=biCrIlhZrC4
5. Podcast by Sudha Murthy - So What If I Lost the Battle, I Lived the War | The Ranveer Show https://www.youtube.com/watch?v=KwXtalUuhLc
6. Motivational Talk by Gour Gopal Das, SLEEPLESS Nights for Overnight SUCCESS https://www.youtube.com/watch?v=YyCXp_E4sMU
7. Motivational Talk by Admiral McRaven's Speech for Your Day, "5 Minutes to Start Your Day Right! - MORNING MOTIVATION" https://www.youtube.com/watch?v=b-Pn0yXL9y8

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

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

| **Course Articulation Matrix (CAM):** | | **U24MH507:** Technical English | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24MH507.1** | - | - | - | - | - | - | - | | 2 | - | 2 | - | - |
| **CO2** | **U24MH507.2** | - | - | - | - | - | - | - | 2 | 2 | - | 2 | - | - |
| **CO3** | **U24MH507.3** | - | - | - | - | - | - | - | | 2 | - | 2 | - | - |
| **CO4** | **U24MH507.4** | - | - | - | - | - | - | - | 2 | 2 | - | 2 | - | - |
| **U24MH507** | | - | | - | - | - | - | - | - | 2 | | - | | - |
| **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 effective listening, speaking, reading and writing skills by understanding native-speaker conversations and expressing ideas clearly and confidently using appropriate vocabulary, while maintaining fluency, coherence and accurate pronunciation. | SDG 4 | Quality Education | This aligns with SDG-4 as it develops effective listening, speaking, reading and writing skills that enable learners to understand native-speakers communication and communicate clearly and fluently with appropriate vocabulary and pronunciation to promote quality education |
| CO2 | enhance communication and professional writing skills through podcast comprehension, group discussions, resume and Quality Education email writing | SDG 4, 8 | Quality Education & Decent work and Economic growth | This aligns with SDG-4 as it promotes quality education by enhancing employability skills and professional writing skills through podcast comprehension, resume writing, critical reading and group discussion This aligns with SDG-8 as it helps students expect productive employment and decent work opportunities by fostering academic and creative thinking |
| CO3 | develop the ability to understand reading texts, conversations of both native and non-native speakers, interpret visual information, and produce clear and well-structured technical reports | SDG 4 | Quality Education | This aligns with SDG-4 as it develops the ability to interpret visual information and produce clear and well-structured technical reports for academic and professional contexts |
| CO4 | develop the ability to present effectively with clarity of speech and appropriate accent | SDG 4 | Quality Education | This aligns with SDG-4 as it enhances effective presentation skills and perform well in interviews |

# POWER ELECTRONICS LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. V Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE508** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 :** rify the characteristics of power semiconductor devices and output waveforms of firing & commutation circuits for SCRs

**CO2 :** lidate the average output voltage and draw the output waveforms of 1-phase semi and fully controlled bridge rectifiers & dual converters for different firing angles

**CO3 :** lidate the output waveforms of AC voltage controller, cycloconverter, inverter and chopper

**CO4 :** nulate power electronic circuits and plot their output waveforms using MATLAB

1. Characteristics of SCR, IGBT & MOSFET
2. Gate firing circuits for SCR
3. Forced commutation circuits (Class A, Class B, Class C & Class D)
4. Single phase semi controlled bridge converter with R & R-L Loads.
5. Single phase fully controlled bridge converter with R & R-L Loads.
6. Single Phase dual converter with R load
7. Four quadrant chopper
8. Single phase AC voltage controller
9. Single phase to Single Phase Cycloconverter
10. Single Phase Mc-Murray Bed ford Bridge inverter
11. Simulation of single-phase full wave rectifier with R and RL load using MATLAB
12. Simulation of single-phase AC voltage controller with R and RL load using MATLAB
13. Simulation of Sinusoidal Pulse Width Modulated inverter using MATLAB
14. Simulation of DC-DC converter using MATLAB (buck, boost, buck-boost and flyback)

**Textbook(s):**


1. P.S. Bhimbra, *Power Electronics*, 6th ed., Khanna Publishers, 2016, New Delhi.


**Reference Book(S):**


1. M.D. Singh & K.B. Kanchandani, *Power Electronics*,., Tata McGraw Hill Education (India) Pvt. Ltd , 2nd ed , 2007. New Delhi.
2. Muhammad H. Rashid, Power Electronics - Circuits, Devices and Applications, Pearson, 2018, 4 th Edition, New Delhi.
3. P.C. Sen, *Power Electronics*,Tata McGraw Hill Education (India) Pvt. Ltd., 2013,New Delhi.
4. Ned Mohan, Tore M. Undeland, Robbins, *Power Electronics: Converters, Applications, and design*, 3rd ed., John Wiley & Sons, 2007, New Jersey.


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

1. https://nptel.ac.in/courses/108/101/108101038/
2. https://nptel.ac.in/courses/108/102/108102145/
3. https://nptel.ac.in/courses/108/101/108101126/
4. https://nptel.ac.in/courses/108/104/108104140/

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

2. *Power Electronics Laboratory Manual,* Department of EEE, KITSW

| Course Articulation Matrix (CAM): | | U24EE508 : POWER ELECTRONICS LABORATORY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE508.1 | 3 | 2 | 1 | 2 | 2 | - | - | - | 1 | - | 1 | 3 | 2 |
| CO2 | U24EE508.2 | 3 | 3 | 2 | 2 | 2 | - | - | - | 1 | - | 1 | 3 | 3 |
| CO3 | U24EE508.3 | 3 | 3 | 3 | 2 | 2 | - | - | - | 1 | - | 1 | 3 | 3 |
| CO4 | U24EE508.4 | 3 | 2 | 2 | 3 | 3 | - | - | - | 1 | - | 2 | 2 | 3 |
| U24EE508 | | 3 | 2.5 | 2 | 2.25 | 2.25 | - | - | | 1 | - | 1.25 | 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 | verify the characteristics of power semiconductor devices and output waveforms of firing & commutation circuits for SCRs | SDG7 | Affordable and Clean Energy | Power semiconductor devices and SCR circuits are essential for efficient energy conversion and control in modern electrical systems. |
| CO2 | validate the average output voltage and draw the output waveforms of 1-phase semi and fully controlled bridge rectifiers & dual converters for different firing angles | SDG9 | Industry, Innovation and Infrastructure | Analysis and validation of converter performance support industrial automation, power control systems, and advanced electrical infrastructure. |
| CO3 | validate the output waveforms of AC voltage controller, cycloconverter, inverter and chopper | SDG13 | Climate Action | Efficient power electronic systems support energy conservation and contribute to lowering environmental impact through optimized energy use. |
| CO4 | simulate power electronic circuits and plot their output waveforms using MATLAB | SDG12 | Responsible Consumption and Production | Simulation reduces the need for repeated hardware testing, saving resources and promoting efficient engineering practices. |

# MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. V – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE509** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 assembly language programs on arithmetic sorting, string & code conversion operations using 8085 microprocessor

**CO2 :** develop assembly language programs for interfacing 8085 microprocessor with I/O devices

**CO3 :** develop assembly language programs on arithmetic & sorting operations using 8051 microcontroller

**CO4 :** develop assembly language programs for interfacing 8051 microcontroller with I/O devices

**Experiment-1 (UNIT-II & UNIT-III)**

**8085 / 8086– Arithmetic & Logic Operations**

1. Develop an ALP for 8-bit addition
2. Develop an ALP for 8-bit subtraction
3. Develop an ALP for 8-bit multiplication
4. Develop an ALP for 8-bit division.

**Experiment-2 (UNIT-II & UNIT-III)**

**8085 / 8086 – Arrays & String Operations**

5. Develop an ALP for n 8-bit numbers.
6. Develop an ALP for finding the average of n 8-bit numbers.
7. Develop an ALP for n multi-byte numbers.
8. Develop an ALP for finding the largest / smallest number in an array
9. Develop an ALP for arranging numbers in ascending order

**Experiment-3 (UNIT-II & UNIT-III)**

**8085 / 8086 – Code Conversion**

10. Develop an ALP for comparing two strings of bytes.
11. Develop an ALP for finding the number of 1's in the given string.

**Experiment-4 (UNIT-II & UNIT-III )**

**8085 / 8086 – Code Conversion**

12. Develop an ALP for converting Binary data to BCD.
13. Develop an ALP for converting BCD to Binary data.
14. Develop an ALP for converting Binary data to ASCII data.

**Experiment-5 (UNIT-II & UNIT-III)**

**8085 / 8086 – Interfacing**

15. Develop an ALP for interfacing ADC / DAC to 8085 microprocessor.

**Experiment-6 (UNIT-II & UNIT-III)**

**8085 / 8086 – Interfacing**

16. Develop an ALP for interfacing LED to 8085 microprocessor.

**Experiment-7 (UNIT-II & UNIT-III)**

**8085 / 8086 – Interfacing**

17. Develop an ALP for interfacing stepper motor to 8085 microprocessor.

**Experiment-8 (UNIT-IV)**

**8051 – Arithmetic operations**

18. Develop an ALP for 8-bit addition
19. Develop an ALP for 8-bit subtraction
20. Develop an ALP for 8-bit multiplication
21. Develop an ALP for 8-bit division.

**Experiment-9 (UNIT-IV)**

**8051 – Arrays & String Operations**

22. Develop an ALP for finding the largest / smallest number in an array
23. Develop an ALP for arranging numbers in ascending / descending order.

**Experiment-10 (UNIT-IV)**

**8051 – Interfacing**

24. Develop an ALP for interfacing stepper motor to 8051 microcontroller.

**Experiment-11 (UNIT-IV)**

**8051 – Interfacing**

25. Develop an ALP for interfacing LED to 8051 microcontroller.

**Experiment-12 (UNIT-IV)**

**8051 – Interfacing**

26. Develop an ALP for interfacing ADC/DAC to 8051 microcontroller.

**Textbook(s):**

1. Ramesh S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, Penram International. *(Chapters 1 to 3, 9 to 12)*
2. Muhammed Ali Mazidi, *The 8051 Microcontrollers and Embedded systems using Assembly and C*, 2nd ed., 2006, Pearson, New Delhi. *(Chapters 1 to 3, 9 to 12)*

**Reference Book(S):**

1. Laboratory Manual, *Microprocessors & Microcontroller Laboratory Manual*, Department of EEE, KITSW

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

*Microprocessors and Microcontroller Systems Laboratory Manual*, Department of EEE, KITSW

| **Course Articulation Matrix (CAM):** | | **U24EE509: MICROPROCESSORS AND MICROCONTROLLER LABORATORY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE509.1** | 2 | - | 1 | - | 1 | - | - | 1 | 2 | 2 | - | 1 | 2 |
| **CO2** | **U24EE509.2** | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 2 | 2 | - | 1 | 2 |
| **CO3** | **U24EE509.3** | 2 | - | - | 1 | 1 | - | - | 1 | 2 | 2 | - | 1 | 2 |
| **CO4** | **U24EE509.4** | 2 | 2 | 2 | 1 | - | 1 | - | 1 | 2 | 2 | - | 1 | 2 |
| **U24EE509** | | 1.75 | 2 | 2 | 1.33 | 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 | develop ALP on arithmetic, sorting, string & code conversion for 8085 | SDG4 | Quality Education | Learning assembly programming develops foundational computing skills and enhances technical education. |
| CO2 | develop ALP for interfacing 8085 with I/O devices | SDG9 | Industry, Innovation and Infrastructure | Interfacing microprocessors with I/O devices (ADC, stepper motor) builds industrial automation skills. |
| CO3 | develop ALP on arithmetic & sorting using 8051 | SDG4 | Quality Education | Programming microcontrollers expands embedded systems knowledge, supporting quality technical education. |
| CO4 | develop ALP for interfacing 8051 with I/O devices | SDG9 | Industry, Innovation and Infrastructure | Interfacing displays and motors with 8051 aligns with industrial automation, robotics, and smart infrastructure development. |

## VI SEMESTER

| S. No. | Category | Course Code | Course Title | Lectures / week | | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | C |
| 1 | OEC | U24OE601X-MB | Open Elective – MB (from Pool -XVII) | 2 | 1 | - | 3 | 3 |
| 2 | PEC | U24EE602 | Program Elective –I / MOOCs-I | 2 | 1 | - | 3 | 3 |
| 3 | PCC | U24EE603 | Power Semiconductor Drives | 2 | 1 | - | 3 | 3 |
| 4 | PCC | U24EE604 | Renewable Energy Systems | 2 | 1 | - | 3 | 3 |
| 5 | PCC | U24EE605 | Artificial Intelligence & Machine Learning | 2 | 1 | - | 3 | 3 |
| 6 | IKSC | U24IK606B | Essence of Indian Traditional Knowledge | 2 | - | - | 2 | 2 |
| 7 | PCC | U24EE607 | Power Semiconductor Drives Laboratory | - | - | 2 | 2 | 1 |
| 8 | PCC | U24EE608 | Renewable Energy Systems Laboratory | - | - | 2 | 2 | 1 |
| 9 | PCC | U24EE609 | Artificial Intelligence & Machine Learning Laboratory | - | - | 2 | 2 | 1 |
| 10 | ELC | U24EE610 | 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-semBridge 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)** | | | | **NIL** | | | | |

## Pool -XVII
## Management Courses Basket (OE-MB)

| S. No. | Course Code | Course Title |
|---|---|---|
| 1. | U24OE601A-MB | Management Economics and Accountancy |
| 2. | U24OE601B-MB | Engineering Finance |
| 3. | U24OE601C-MB | Organisational Behaviour |
| 4. | U24OE601D-MB | E-Commerce and Digital Marketing |
| 5. | U24OE601Z-MB | Any other course approved by BoS Chair and Dean AA |

## Bridge Courses for exit:

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

**(OR)**

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

## C. After Third Year:(B. Voc. in EEE)

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

| **Exit Option to Qualify B. Voc in EEE: Any Two (02) Courses during the 2 - Months internship** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S. No. | Category | Course Code | Course Title | L | T | P | O | E | C |
| 1 | PCC | U24EE611X | Testing and maintenance of AC machines | 2 | - | 2 | - | 4 | 3 |
| 2 | PCC | U24EE612X | Testing and maintenance of batteries and solar cell | 2 | - | 2 | - | 4 | 3 |
| 3 | PCC | U24EE613X | Introduction to Control of Electric Vehicle | 2 | - | 2 | - | 4 | 3 |
| 4 | PCC | U24EE614X | Any other course approved by BoS Chair and Dean AA | 2 | - | 2 | - | 4 | 3 |

**(OR)**

**(ii) Any two suitable skill-based courses to qualify for B. Voc in EEE Degree.**

| **Exit Option to Qualify B. Voc in EEE: Any Two (02) Skill based Courses:** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S. No. | Category | Course Code | Course Title | L | T | P | O | E | C |
| 1 | SEC | U24SE611X | Introduction to Hybrid Electric Vehicle using MATLAB and Simulink | - | - | 6 | - | 6 | 3 |
| 2 | SEC | U24SE612X | Installation of Solar PV panel | - | - | 6 | - | 6 | 3 |
| 3 | SEC | U24SE613X | Fault Detection and troubleshooting of inverter, stabilizer, UPS & battery charger | - | - | 6 | - | 6 | 3 |
| 4 | SEC | U24SE614X | Any other skill based course approved by BoS Chair and Dean AA | - | - | 6 | - | 6 | 3 |

***(Note to HoDs on PCC: Under PCC the departments shall plan appropriate courses upto 6$^{th}$ semester covering GATE syllabus).***

# MANAGEMENT ECONOMICS AND ACCOUNTANCY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch: CSE,ECE,ECI,EEE/ CSN,CSO,CSM,CSD,IT,CE,ME** | |
| **Course Code:** | **U24OE601A-MB** | **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 and Scope of Management, Fayol's Administrative Management, Taylor's Scientific Management

**Functions of Management: Planning-** Concept of Planning, Nature of Planning, Importance of Planning, Planning Process, Types of Planning; **Organizing**-Concept of Organizing, Organization Structure- line and staff, Advantages of Organizing; **Staffing** - Meaning, Functions of Human Resources Management; **Directing**- Elements of Directing- Supervision; Leadership- Nature; Motivation - Nature, Types; Communication- Process, Types, Barriers to effective communication; **Co-ordination**- Definition, Steps to achieve effective coordination; **Controlling**- Definition, Process

| **UNIT-II** | **9 Hrs** |
|---|---|

**Economics:** Meaning and definition, Scope, Micro and Macro Economics, Methods of Economics

**Forms of Business Organization:** Sole Proprietor ship, Partnership firm - Types of Partners, Limited Liability Partnership (LLP), Joint Stock Company - Features, Types, Merits and demerits, Cooperative society

| **UNIT-III** | **9 Hrs** |
|---|---|

**Introduction to Financial Accounting:** Accounting concepts and conventions, Double Entry System and Book Keeping, Overview of accounting cycle, Journal-meaning, Journalizing, Ledger - Meaning, Ledger posting, Balancing; Cash book (Single column), Preparation of Trial balance

**Final Accounts:** Trading Account, profit and loss account and Balance Sheet with simple adjustments

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Financial Statement Analysis:** Introduction to Financial Statement Analysis**,** Ratio Analysis, Introduction, Types of Ratios, Analysis and Interpretation of Liquidity Ratios, Profitability ratios, Activity Ratios, and Capital structure Ratios (simple problems)

**Textbook(s):**

1.L.M.Prasad, *Principles and Practices of Management,* Sultan Chand & Sons Educational Publishers, 11th edition.2025, New Delhi. (Part –I to Part-VI)

2. D. N. Dwivedi, *Engineering Economics*: *Text & Cases*, Vikas Publishing, 5th edition, 2014. (Chapter-3)
3. R. Narayana Swamy, *Financial Accounting – A Managerial Perspective*, Prentice Hall of India, 7th edition, 2023,new Delhi.( Chapter VI)

**Reference Book(S):**

1. Harold Koontz and Heinz Weihrich, Essentials of Management, 6th ed. New Delhi: Tata Mc Graw Hill Publications, 2015.
2. Maheshwari, S. N., & Maheshwari, S. K. (2024). Financial Accounting (7th ed.). Vikas Publishing House Pvt. Ltd, 2024.

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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_mg52
https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ec10

**Course Articulation Matrix (CAM):**
**U24OE601A-MB MANAGEMENT ECONOMICS AND ACCOUNTANCY**

| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | U24MB601A-MB.1 | - | 3 | 3 | 2 | - | 2 | 2 | 3 | 3 | 3 | 3 | | |
| CO2 | U24MB601A-MB.2 | - | 2 | 2 | - | - | 2 | 3 | 3 | 3 | 3 | 3 | | |
| CO3 | U24MB601A-MB.3 | - | 1 | 2 | 1 | - | 2 | 3 | 2 | 3 | 3 | 3 | | |
| CO4 | U24MB601A-MB.4 | - | 2 | 2 | 2 | - | 1 | 2 | - | 3 | 2 | 3 | | |
| U24MB601A-MB | | - | 2 | 2.25 | 1.67 | - | 1.75 | 2.5 | 2.67 | 3 | 2.75 | 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 | 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. |

# ENGINEERING FINANCE

| | | | |
|---|---|---|---|
| **Class:** B.Tech. VI | | **Branch:** CSE, ECE, ECI, EEE/ CSN, CSO, CSM, CSD, IT, CE, and ME | |
| **Course Code:** | **U24OE601B-MB** | **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 making and cost control; Ethics in Engineering Finance – Transparency, Cost estimation honesty, Avoidance of financial conflicts of interest; Financial Management – Meaning, Functions, Objectives (profit maximization v/s. wealth maximization), Sources of Finance, Time value of Money.

| **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, 5th edition, ISBN: 9788126510887, 2014.
4. Prasanna Chandhra, *Financial Management: Theory and Practice,* Tata Mc Graw Hill Education (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.


## Course Articulation Matrix (CAM):

| 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** | **U24OE601B-MB.1** | 2 | - | - | - | - | - | 2 | - | - | 2 | 2 | | |
| **CO2** | **U24OE601B-MB.2** | | 3 | | | 2 | | | | | | 3 | | |
| **CO3** | **U24OE601B-MB.3** | | | 2 | | | | | 2 | | 2 | | | |
| **CO4** | **U24OE601B-MB.4** | | | 2 | 2 | | 2 | | | | 2 | 2 | | |
| | **U24OE601B-MB** | 2 | 3 | 2 | 2 | 2 | 2 | | 2 | | 2 | 2.3 | | |

3 – HIGH, 2 – MEDIUM, 1 – LOW

**CO–SDG Alignment Matrix**

| CO | CO Statement<br>*The student should be able to…* | Relevant SDG | SDG Description | Mapping Justification |
|---|---|---|---|---|
| CO1 | 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 point for make or buy decisions in engineering projects. | SDG 9 And SDG 12 | Industry, Innovation and Infrastructure and Responsible Consumption and Production | Encourages cost efficiency, optimized production planning, 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. |

# ORGANISATIONAL BEHAVIOUR

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | Branch: CSE,ECE,ECI,EEE/ CSN,CSO,CSM,CSD,IT,CE,ME | |
| **Course Code:** | **U24OE601C-MB** | **Credits:** | **3** |
| **Hours/Week (L-T-P- E):** | **2-1-0-3** | **CIE:** | **40%** |
| **Total Number of Teaching Hours:** | **36 Hrs** | **ESE:** | **60%** |

**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):**

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): | | U24OE601C-MB ORGANIZATIONAL BEHAVIOUR | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24OE601C-MB.1 | 2 | - | - | - | - | - | - | 2 | 2 | - | - | - | - |
| CO2 | U24OE601C-MB.2 | - | 3 | - | - | - | - | 2 | -- | - | - | 3 | - | - |
| CO3 | U24OE601C-MB.3 | - | 2 | - | - | - | - | - | 2 | 2 | 2 | - | - | - |
| CO4 | U24OE601C-MB.4 | - | - | 2 | - | - | 2 | - | - | - | 2 | 2 | - | - |
| | | 2 | 2.5 | 2 | - | - | 2 | 2 | 2 | 2 | 2 | 2.5 | - | - |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*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 behaviour including personality, perception, learning, attitudes, emotions, stress, and motivation. | SDG 3 | Good Health and Well-being | Analysing emotions, stress, 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:** CSE, ECE, ECI, EEE/ CSN,CSO,CSM,CSD,IT,CE,ME | |
| **Course Code:** | **U24OE601D-MB** | **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):** | | **E-COMMERCE & DIGITAL MARKETING** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24OE601D-MB U24OE701D-MB** | 2 | 2 | 1 | | 2 | 1 | | | 1 | | 2 | | |
| **CO2** | **U24OE601D-MB U24OE701D-MB** | 2 | 2 | 1 | 1 | 2 | 2 | 1 | | 1 | 1 | 1 | | |
| **CO3** | **U24OE601D-MB U24OE701D-MB** | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | | |
| **CO4** | **U24OE601D-MB U24OE701D-MB** | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | | |
| | | **2** | **2** | **1.5** | **1.3** | **2** | **1.25** | **1** | **1.5** | **1.5** | **1.3** | **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 | Understand the concepts, 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 | Analyze digital 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 |

# HIGH VOLTAGE ENGINEERING

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE602A** | **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,*
*(based on cognitive skills acquired from theory component)*

**CO1 :** *analyze the breakdown mechanisms in gaseous, liquid and solid dielectric media.*

**CO2 :** *apply the principles of high-voltage generation circuits to generate AC, DC, impulse voltages and currents*

**CO3 :** *apply the principles of electrical measurements for measuring AC, DC, impulse voltages and currents*

**CO4 :** *analyze the over voltage phenomena in power systems and explain the power frequency and impulse teststing techniques for power system components*

| **UNIT-I** | **9 Hrs** |
|---|---|

Breakdown Mechanism of Gases: Townsend's first ionization coefficient, cathode processor, secondary effects, Townsend's second ionization coefficient, Townsend's breakdown mechanism, experimental determination of coefficients and breakdown in electronegative gases, steamer or Kanal mechanism of breakdown, Paschen's Law, Penning effect, breakdown in non-uniform fields and corona discharges, time-lag, practical considerations in using gases for insulation purposes, vacuum insulation

**Breakdown Mechanism of Solids and Liquids:** Introduction, intrinsic breakdown, electro mechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, chemical and electro chemical deterioration and breakdown, breakdown due to treeing and tracking, breakdown due to internal discharges, breakdown in composite dielectrics, liquids as insulators, pure liquids and commercial liquids, conduction and breakdown in commercial liquids-suspended particle theory, cavitation and the bubble theory, thermal mechanism of breakdown, stressed volume theory

| **UNIT-II** | **9 Hrs** |
|---|---|

**Generation of High DC & AC Voltages and Currents**: Half wave rectifier circuit, voltage doubler circuits, Cockcroft-Walton voltage multiplier circuit, electrostatic generator, Vande Graaff generator, generation of high AC voltages, cascaded transformers, resonant transformer, generation of high frequency AC High voltages, generation of rectangular current pulses, tripping control of impulse generator

**Generation of High Impulse Voltages and Currents:** Definition of impulse currents & voltages, impulse voltage generator circuits, Marx's multistage voltage generator, tripping control of impulse voltage generator, generation of switching surges, definition of impulse current wave forms, impulse current generator

| **UNIT-III** | **9 Hrs** |
|---|---|

**Measurement of High Voltage DC, AC and Impulse Voltages**: High ohm series resistance, resistance potential divider, R-C capacitive voltage divider, generating voltmeter series capacitance voltmeter, CVT, electrostatic voltmeters, peak reading AC voltmeters (Chubb Fortescue method), spherical measurements (spherical gaps) for high DC and AC voltages, impulse voltages

**Measurement of High Currents**: Hall generators for DC current measurements, resistive shunts, bipolar strip shunt, coaxial tubular shunt, squirrel cage shunts

**Cathode Ray Oscillographs for Impulse Measurements.**

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Overvoltage Phenomenon:** Lightning phenomenon, overvoltages due to switching surges, system faults and other abnormal conditions, principle of insulation co-ordination on HV and EHV power systems

**High Voltage Testing Techniques:** Power frequency and impulse testing of insulators, bushings, cables, transformers, surge diverters, isolators and circuit breakers

**Textbook(s):**

1. M.S. Naidu,V. Kamaraju, *High Voltage Engineering*, 6th ed., McGraw Hill Education Pvt. Ltd., 2019, New Delhi, India.

**Reference Book(S):**

1. E. Kuffel, W. S. Zaengl, and J. Kuffel, *High Voltage Engineering Fundamentals*, 2nd ed., Oxford: Newnes (Elsevier), 2010.
2. D. Kind, K. Feser, *High Voltage Test Techniques*, 2nd ed., Oxford: Newnes (Elsevier), 2001.
3. C.L. Wadhwa, *High Voltage Engineering*, 3rd ed., New Age International Pvt. Ltd., 2012, New Delhi.
4. Subir Ray, *An Introduction to High Voltage Engineering*, 2nd ed., Prentice Hall of India, 2013, New Delhi.

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

ps://www.youtube.com/playlist?list=PLyrUxF16ZZ6OOn1Tw7jeGIRpu7UiHYDSo;*NPTEL Course Lectures on High Voltage Engineering by Prof. Ravindra Arora and Dr. Bharat Singh Rajpurohit, IIT Mandi, H.P., India*

| **Course Articulation Matrix (CAM):** | | **U24EE602A: HIGH VOLTAGE ENGINEERING** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE602A.1** | 1 | 2 | 1 | 1 | 1 | 1 | - | - | - | - | 1 | 2 | 1 |
| **CO2** | **U24EE602A.2** | 2 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | 1 | 2 | 1 |
| **CO3** | **U24EE602A.3** | 2 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | 1 | 2 | 1 |
| **CO4** | **U24EE602A.4** | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | - | 1 | 2 | 1 |
| **U24EE602A** | | **1.75** | **1.25** | **1.5** | **1.5** | **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 | breakdown mechanisms in solid, liquid and gaseous dielectrics | SDG 9 | Industry, Innovation, and Infrastructure | Understanding dielectric breakdown ensures reliable insulation in power cables, transformers, and switchgear, which is fundamental for resilient electrical infrastructure (Target 9.1) |
| CO2 | methods and circuits to generate high DC, AC, impulse voltages and currents | SDG 7 | Affordable and Clean Energy | High voltage generation circuits (e.g., Marx generators, cascaded transformers) are essential for efficient long-distance power transmission, reducing losses and enabling access to clean/renewable energy sources (Target 7.2, 7.3) |
| CO3 | techniques employed in high voltage and current measurements | SDG 9 | Industry, Innovation, and Infrastructure | Accurate HV measurement techniques (CVT, Hall generators, CROs) enable quality control and condition monitoring of power apparatus, supporting reliable and |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement** *The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | | | | safe industrial electrification (Target 9.4) |
| CO4 | causes of over voltages and impulse and power frequency tests on the power system components | SDG 11 | Sustainable Cities and Communities | Overvoltage protection and HV testing of insulators, bushings, cables, and breakers directly ensure safe and resilient urban power distribution, preventing lightning/switching surge-induced failures and fires (Target 11.5: reduce disaster impact) |

# SPECIAL ELECTRICAL MACHINES

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI–Semester | | **Branch:** EEE | |
| **Course Code:** | U24EE602B | **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,*

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

**CO1 :** *Select the SRM and SyRM drives for industrial applications.*

**CO2 :** *analyze the performance characteristics of PMDC and BLDC motors.*

**CO3 :** *analyze the performance and applications of PMSM and 1-Φ special machines.*

**CO4 :** *analyze the operating characteristics of linear electrical machines and compare them with conventional machines.*

| **UNIT-I** | **9 Hrs** |
|---|---|

**Switched Reluctance Motor(SRM):** Construction, Principle Of Working, SRM Analysis, Torque Equation And Characteristics, Power Converter Circuits, Control Of SRM, Rotor Position Sensors, Sensorless Control, applications

**Synchronous Reluctance Motor (SyRM):** construction of SyRM, working of SyRM, phasor diagram & torque equation and control of SyRM, advantages, applications

| **UNIT-II** | **9 Hrs** |
|---|---|

**PMDC Motor:** Construction, Principle of Working, Torque Equation & Equivalent circuit, performance characteristics

**Brushless PMDC Motor (BLDC)**: classification, construction, electronic commutation, principle of operation, types and control of BLDC motor, comparison of conventional DC motor and BLDC motor, applications of BLDC motor

| **UNIT-III** | **9 Hrs** |
|---|---|

**Permanent Magnet Synchronous Motor(PMSM):** construction, principle of operation, EMF equation and torque equation, phasor diagram and circle diagram of PMSM, Comparison of conventional and PM synchronous motors, self-control of PMSM and sensor less control of PMSM, applications of PMSM

**AC series motor:** construction, principle of working, EMF and torque equation, phasor diagram and torque speed characteristics.

**Repulsion motor:** construction and working, types of repulsion motor, torque equation, characteristics and phasor diagram

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Linear Induction Motor(LIM):** construction and thrust equations, performance equations, equivalent circuits, characteristics and control, applications

**Linear Synchronous Motor (LSR):** types of construction, thrust equation and control of LSR, applications.

**Textbook(s):**

1. E.G. Janardhan, Special Electrical Machines, PHI Delhi, 2014

**Reference Book(S):**

1. P.S.Bhimbra, Electrical Machinery, Khanna publications, New Delhi, fully revised edition,2021

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

- https://youtu.be/Nn1V9KLrtX4?si=KSL6UFNDGbxL4bEf NPTEL Course on special electrical machines

| Course Articulation Matrix (CAM): | | U24EE602B : **SPECIAL PURPOSE MACHINES** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE602B.1** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| **CO2** | **U24EE602B.2** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| **CO3** | **U24EE602B.3** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| **CO4** | **U24EE602B.4** | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| **U24AI505** | | **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 | Select the SRM and SyRM for industrial applications | SDG9 | Industry, Innovation and Infrastructure | Selection and application of SRM and SyRM improve industrial automation, energy-efficient motor drives, and modern electrical infrastructure, supporting sustainable industrial innovation. |
| CO2 | Analyze the performance of BLDC and PMDC motors & Solve Problems | SDG7 | Affordable and Clean Energy | BLDC and PMDC motors provide high efficiency and reduced energy losses in electric drives, supporting energy conservation and clean energy utilization. |
| CO3 | Identify the applications of PMSM and 1-Φ special machines | SDG11 | Sustainable Cities and Communities | PMSM and single-phase special machines are widely used in electric vehicles, household appliances, and smart transportation systems, contributing to sustainable urban development. |
| CO4 | Compare the conventional machines with linear machines &Solve Problems | SDG13 | Climate Action | Linear electrical machines improve transportation efficiency and reduce environmental impact in applications such as high-speed rail systems, supporting climate-friendly technologies. |

# MODERN CONTROL THEORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE602C** | **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 and analyze state-space models of linear continuous-time systems, determine system responses using state transition matrices, and represent systems in suitable canonical forms

**CO2 :** Analyze controllability and observability of continuous-time systems using standard tests and perform state transformations into different canonical forms

**CO3:** Evaluate the stability of linear systems using Lyapunov stability theory and construct suitable Lyapunov functions for stability analysis

**CO4:** Design state feedback controllers and state observers using pole placement techniques and analyze observer-based control systems for desired performance

| **UNIT-I** | **9 Hrs** |
|---|---|

**State Variable Analysis:** Introduction to modern control theory, Concept of state, state variables, and state vector State-space representation of systems, eigenvalues and eigenvectors, canonical form representation of linear systems. Concept of state, state-space model of dynamic systems, time invariance and linearity, non-uniqueness of state models, state diagrams for continuous-time systems. Existence and uniqueness of solutions to continuous-time state equations, solution of linear time-invariant (LTI) state equations, state transition matrix and its properties, Complete solution of state-space models due to zero input and zero state responses

| **UNIT-II** | **9 Hrs** |
|---|---|

**Controllability and Observability:** Concept of controllability and controllability tests for continuous-time invariant systems. State transformations: diagonal canonical form, Jordan canonical form, and controllability canonical form. Concept of observability and observability tests for continuous-time invariant systems, Observability of different state transformation forms and duality between controllability and observability

| **UNIT-III** | **9 Hrs** |
|---|---|

**Stability Analysis:** Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems, Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method, Generation of Lyapunov functions, Variable gradient method, Krasooviski's method

| **UNIT-IV** | **9 Hrs** |
|---|---|

**State Feedback Controllers and Observers:**

**State feedback and pole placement techniques:** Design of state feedback controllers through pole assignment using Ackermann's formula.

**State observers:** full-order observers and reduced-order observers, Design and analysis of observer-based control systems.

**Textbook(s):**

1. Ogata. K, "*Modern Control Engineering*", Pearson Education India, 5th edition, 2015.

**Reference Book(S):**

1. M.Gopal, "Modern Control System Theory", New Age International Private Limited, 3rd edition, 2015.
2. A. Roy Choudhary, *Modern Control Engineering,* Prentice Hall India, 2005, 1st Edition.

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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee98; *NPTEL Video Lecture on Advanced Linear Continuous Control Systems by Prof. Yogesh Vijay Hote, Professor of EEE, IIT Roorkee.*

| Course Articulation Matrix (CAM): | | U24EE602C: MODERN CONTROL THEORY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE602C.1 | 3 | 2 | 1 | 2 | 2 | – | – | – | – | – | – | 3 | 2 |
| CO2 | U24EE602C.2 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | – | 3 | 3 |
| CO3 | U24EE602C.3 | 3 | 3 | 2 | 3 | 2 | – | – | – | – | – | – | 2 | 3 |
| CO4 | U24EE602C.4 | 3 | 3 | 3 | 2 | 2 | – | – | – | 1 | 1 | 1 | 3 | 3 |
| U24EE602C | | 3 | 2.75 | 2 | 2.25 | 2 | - | - | - | 1 | 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 and analyze state-space models of linear continuous-time systems, determine system responses using state transition matrices, and represent systems in suitable canonical forms. | SDG9 | Industry, Innovation and Infrastructure | State-space modeling and system analysis develop advanced engineering knowledge required for modern automation and industrial control applications. |
| CO2 | Analyze controllability and observability of continuous-time systems using standard tests and perform state transformations into different canonical forms. | SDG9 | Industry, Innovation and Infrastructure | Controllability and observability analysis support the design of reliable and efficient modern control systems used in industrial infrastructure. |
| CO3 | Evaluate the stability of linear systems using Lyapunov stability theory and construct suitable Lyapunov functions for stability analysis. | SDG9 | Industry, Innovation and Infrastructure | Stability analysis ensures safe, reliable, and efficient operation of electrical and industrial control systems. |
| CO4 | Design state feedback controllers and state observers using pole placement techniques and analyze observer-based control systems for desired performance. | SDG9 | Industry, Innovation and Infrastructure | smart infrastructure, and efficient operation of modern engineering systems. |

# POWER SEMICONDUCTOR DRIVES

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE603** | **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 fundamental torque equations to determine the dynamic behavior of electric drives
**CO2 :** design control schemes for rectifier & chopper-controlled DC drives
**CO3 :** design control schemes for squirrel cage and wound rotor induction motor drives
**CO4 :** distinguish the operation of self-controlled & true controlled synchronous motor drives

| **UNIT-I** | **9 Hrs** |
|---|---|

Fundamentals of Electric Drives: Electric drives, advantages of electric drives, parts of electric drives, choice of electric drives, status of DC drives and AC drives, Starting, braking, speed control of motors

Dynamics of electric drives: Fundamental torque equations, types of load, quadrant diagram of speed- torque characteristics, dynamics of load torque combinality, steady state stability and transient stability of an electric drives, load equalization, calculation of time and energy loss in transient operation, drive specifications

| **UNIT-II** | **9 Hrs** |
|---|---|

**Rectifier Control of DC drives:** Controlled rectifier circuits, braking operation of rectifier controlled separately excited DC motor, single phase and three phase half and fully controlled rectifier fed separately excited DC motor, multi quadrant operation of fully controlled rectifier fed separately excited DC motor

**Chopper control of DC drives:** chopper control of separately excited and series DC motors, multi quadrant control of chopper fed motors

| **UNIT-III** | **9 Hrs** |
|---|---|

**Control of Induction Motor Drives**: Braking and speed control of induction motor

**AC Voltage Controllers**: Control of induction motor by AC voltage controllers

**Frequency-controlled Induction Motor Drives:** Control of induction motor by Voltage Source Inverter(VSI), Current Source Inverter (CSI), Current controlled PWM inverters

**Slip Power-controlled Wound-Rotor Induction Motor Drives:** static rotor resistance control, constant torque and constant power drives (*static Scherbius & Kramer drives)*

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Control of Synchronous Motor Drives:** Braking and speed control of synchronous motor, Operation of cylindrical rotor synchronous motor from VSI and CSI, self-controlled synchronous motor drives using cyclo converters, permanent magnet AC motor drives

**Textbook(s):**


1. Gopal.K. Dubey, *Fundamentals of Electrical Drives*, 2nd ed., New Delhi: Narosa Publishers, Reprint: 2019.


**Reference Book(S):**


1. Vedam Subrahmanyam, *Thyristor Control of Electrical Drives*, 2nd ed., New Delhi: McGraw Hill Education (India) Pvt. Ltd., 2017.
2. B.K. Bose, *Modern Power Electronics & A.C Drives*, New Delhi: Pearson edu. Pvt. Ltd., 2002.
3. P.S. Bimbhra, *Power Electronics*, 6th ed., New Delhi: Khanna Publishers, 2012.
4. N.K. De and P.K. Sen, *Electrical Drives*, New Delhi: Prentice Hall of India, 1999.


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

https://nptel.ac.in/courses/108104140; *NPTEL Video Course on Fundamentals of Electric Drives by Prof. S.P. Das, Professor at Department of Electrical Engineering, IIT Kanpur*

| Course Articulation Matrix (CAM): | | U24EE603: POWER SEMICONDUCTOR DRIVES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE603.1 | 2 | 2 | 1 | 1 | - | 1 | - | - | - | - | 1 | 2 | 1 |
| CO2 | U24EE603.2 | 3 | 3 | 1 | 1 | 1 | 1 | - | - | - | - | 1 | 2 | 1 |
| CO3 | U24EE603.3 | 3 | 3 | 1 | 1 | 1 | 1 | - | - | - | - | - | 2 | 2 |
| CO4 | U24EE603.4 | 2 | 2 | 1 | - | 1 | 1 | - | - | - | - | - | 2 | 2 |
| U24EE603 | | 2.5 | 2.5 | 1.0 | 1.0 | 1.0 | 1.0 | - | - | - | - | 1.0 | 2.0 | 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 | apply fundamental torque equations to determine the dynamic behavior of electric drives | SDG 7 | Affordable and Clean Energy | Efficient selection and estimation of industrial drives improves energy utilization and proper torque analysis helps in selecting and controlling motors for energy-efficient applications |
| CO2 | design control schemes for rectifier & chopper-controlled DC drives | SDG 9 | Industry, Innovation and Infrastructure | Advanced DC drive control enhances energy efficiency, automation, and modern industrial applications |
| CO3 | design control schemes for squirrel cage and wound rotor induction motor drives | SDG 9 | Industry, Innovation and Infrastructure | Efficient induction motor drive systems with proper starting, speed control and braking methods reduce industrial power losses and provide efficient usage of infrastructure |
| CO4 | distinguish the operation of self-controlled & true controlled synchronous motor drives | SDG 9 | Industry, Innovation and Infrastructure | Understanding advanced synchronous motor drives supports development of high-efficiency industrial and smart drive systems |

# RENEWABLE ENERGY SYSTEMS

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE604** | **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,*
*(based on cognitive skills acquired from theory component)*

**CO1 :** analyze renewable and conventional energy resources and asses the suitability of solar PV systems for various applications

**CO2 :** analyze the wind power developed by a wind energy system and the operational difficulties associated with geothermal energy

**CO3 :** analyze the feasibility of harnessing of electric power from oceans and biomass

**CO4 :** select an appropriate energy storage system for a given application and summarize the operating principle of fuel cell

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction**: Conventional and non-conventional sources of energy – brief description of different renewable energy sources

**Solar energy**: Introduction to prospects of solar PV systems: photovoltaic effect and electrical equivalent circuit of a PV cell, dependence of a PV cell characteristic on temperature, solar cell output characteristics, solar maximum power point tracking (MPPT) using Perturb &Observe algorithm, applications of solar PV systems- street lighting, domestic lighting, solar PV pumping systems

| **UNIT-II** | **9 Hrs** |
|---|---|

**Wind energy**: Principles of wind power, evaluation of wind intensity, operation of a wind turbine and wind power curve, different types of wind turbine generators, topography and classification of wind turbines and its applications

**Geothermal Energy**: Origin and types of geothermal energy, operational difficulties, liquid dominated systems

| **UNIT-III** | **9 Hrs** |
|---|---|

**Energy from Oceans**: Ocean temperature differences, ocean waves, energy from the waves, introduction of tidal power, basic principle of tidal power, components of tidal power plants

**Bioenergy**: Introduction, bio-mass conversion technologies, photo synthesis, biogas generation, biogas from power plant wastes, methods of maintaining biogas production, utilization of biogas, biogas gasification

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Chemical energy sources**: Introduction to fuel cells, principle of operation of fuel cell, classification of fuel cells, advantages, disadvantages and applications of fuel cells

**Types of energy storage systems**: Introduction, mechanical energy storage systems, batteries, ultra-capacitors, super conducting magnetic storage, applications

**Textbook(s):**


1. Rai G.D, *Non-Conventional Energy Sources*, 4th ed. New Delhi: Khanna Publishers, 2010.


**Reference Book(S):**


1. B.H. Khan, *Non-conventional Energy Resources*, 2nd ed. New Delhi: McGraw Hill Education (India) Pvt. Ltd., 2006.
2. Felix A. Farret, M. Godoy Simoes, *Integration of Alternative Sources of Energy*, New Jersey: John Wiley & Sons, 2006.
3. Bansal N. K,Kaleeman, M.Miller, *Renewable Energy Sources and Conversion Technology*, New Delhi: Tata McGraw Hill Education (India) Pvt. Ltd., 2006.
4. Duffie and Beckman, *Solar Energy Thermal Process*, New Jersey: John Wiley & Sons, 2006.


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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ch40

| Course Articulation Matrix (CAM): | | U24EE604 RENEWABLE ENERGY SYSTEMS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE604.1 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 3 |
| CO2 | U24EE604.2 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 3 |
| CO3 | U24EE604.3 | 3 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| CO4 | U24EE604.4 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 |
| U24EE604 | | 3 | 2.5 | 2 | 1 | 1.75 | 2.25 | 1 | 1 | 1 | 1 | 2 | 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 | Evaluate the sources of renewable and conventional energy resources, quantify solar power and judge the applicability of solar energy. | SDG7 | Affordable and Clean Energy | Solar energy is one of the most widely adopted renewable energy sources. Understanding solar PV systems, energy conversion, and applications promotes access to clean, reliable, and sustainable energy. |
| CO2 | Analyze the wind power developed by a wind energy system and the operational difficulties associated with geothermal energy. | SDG9 | Industry, Innovation and Infrastructure | Wind and geothermal energy technologies contribute to sustainable infrastructure development and technological innovation in the energy sector, supporting cleaner industrial growth. |
| CO3 | Analyze the feasibility of harnessing electric power from oceans and biomass. | SDG13 | Climate Action | Ocean and biomass energy systems reduce dependence on fossil fuels and help mitigate greenhouse gas emissions, thereby supporting climate action and environmental sustainability. |
| CO4 | Select an appropriate energy storage system for a given application and summarize the operating principle of fuel cell. | SDG7 | Affordable and Clean Energy | Energy storage systems and fuel cells improve the reliability, efficiency, and integration of renewable energy sources, enabling sustainable and clean energy utilization. |

# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE605** | **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 Artificial Intelligence and Machine Learning concepts to implement the Machine Learning pipeline using Python libraries for data analysis, model training, and performance evaluation.

**CO2 :** apply supervised learning techniques such as regression and classification for predictive modelling

**CO3 :** implement unsupervised learning techniques including clustering, dimensionality reduction.

**CO4 :** design and implement Artificial Neural Networks using backpropagation and optimization techniques.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction:** Evolution of Artificial Intelligence, Relationship between AI, Machine Learning and Deep Learning, Workflow of ML system

**Python for Machine Learning:** Overview of Python libraries – NumPy, Pandas, Matplotlib, Seaborn

D**ata Pre-processing:** Need for Data Pre-processing, Data collection, Data cleaning, Data Integration, Data Transformation, Data Reduction, Model selection, Training and Testing Features scaling-Normalization and Data visualization

| **UNIT-II** | **9 Hrs** |
|---|---|

**Supervised Learning – Regression:** Simple and Multiple Linear Regression

**Model Evaluation Metrics:** Accuracy, Precision, Recall, Confusion Matrix, Mean Squared Error, $R^2$ Score

**Supervised Learning – Classification:** Types of classification, Decision Trees, Random Forest, Naive Bayes, k-Nearest Neighbour(k-NN), Logistic Regression, Support Vector Machine (SVM)

| **UNIT-III** | **9 Hrs** |
|---|---|

**Unsupervised Learning – Clustering and Dimensionality Reduction:** Introduction, Applications, Features, Distance metrics, Partitioning clustering- K-Means Clustering, Dimensionality Reduction- Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA)

**Ensemble learning:** Bagging -Random Forest, Boosting-AdaBoost, XGBoost, Case study on AdaBoost using Load forecasting

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Artificial Neural Networks:** Biological vs Artificial neuron, Need for neural networks, Building Blocks of Neural Network- Neuron model, Weights, bias, Layers (input, hidden, output); Activation & Loss Functions - Sigmoid, Tanh, ReLU, Softmax, Cross-Entropy, Mean Absolute Error (MAE); Implementation of Convolution Neural Networks (CNN), Introduction to Edge AI and TinyML

**Optimizers & Training Process:** Gradient Descent Variants, Forward propagation, Back propagation (basic idea), Epochs, Iterations, Data Pre-processing for neural networks, Feature Engineering, over fitting and Under fitting, Hyper parameters

**Textbook(s):**


1. Parteek Bhatia, *Machine Learning with Python*, Cambridge University Press, 2023.


**Reference Book(S):**


1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd edition , O'Reilly Media, 2022.
2. Sebastian Raschka, Vahid Mirjalili, Python Machine Learning, Packt Publishing, 3rd edition, 2019.


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

https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Introduction to Machine Learning by Prof. Sudeshna Sarkar, Professor of CSE, IIT Kharagpur.*

| Course Articulation Matrix (CAM): | | U24EE605 : ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE605.1 | 2 | 2 | 1 | 1 | 3 | - | - | - | - | - | 2 | 1 | 1 |
| CO2 | U24EE605.2 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | - | 2 | 2 | 2 |
| CO3 | U24EE605.3 | 2 | 3 | 2 | 2 | 3 | - | 1 | - | - | - | 2 | 2 | 2 |
| CO4 | U24EE605.4 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | - | - | - | 2 | 2 | 3 |
| U24EE605 | | 2.5 | 2.75 | 2 | 1.75 | 3 | 1 | 1 | - | - | - | 2 | 1.75 | 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 Artificial Intelligence and Machine Learning concepts to implement the Machine Learning pipeline using Python libraries for data analysis, model training, and performance evaluation. | SDG4 | Quality Education | Python-based machine learning tools and structured ML pipeline learning enhance technical education and develop computational, programming, and data analysis skills among engineering students. |
| CO2 | apply supervised learning techniques such as regression and classification for predictive modelling | SDG9 | Industry, Innovation and Infrastructure | Supervised learning techniques support intelligent Electrical Engineering applications such as load forecasting, fault detection, predictive maintenance and smart grid analytics |
| CO3 | Implement unsupervised learning techniques including clustering and dimensionality reduction | SDG11 | Sustainable Cities and Communities | Clustering and dimensionality reduction techniques enable intelligent energy management, smart monitoring, anomaly detection, and data-driven optimization for sustainable electrical infrastructure and smart city applications. |
| CO4 | design and implement Artificial Neural Networks using backpropagation and optimization techniques. | SDG13 | Climate Action | Artificial Neural Networks and optimization techniques support renewable energy forecasting, intelligent energy management, energy-efficient systems, and sustainable AI-driven solutions contributing to climate action and environmental sustainability. |

# ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

| | | | |
|---|---|---|---|
| **Class:** B.Tech. VI – Semester | **Branch:** CSE, EEE, ECE, ECV | | |
| **Course Code:** | U26IK606B | **Credits:** | **2** |
| **Hours/Week (L-T-P-E):** | **2-0-0-2** | **CIE:** | **40%** |
| **Total Number of Teaching Hours:** | **24 Hrs** | **ESE:** | **60%** |

**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: Vidyanidhi Prakasham, 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):**

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

| Course Articulation Matrix (CAM): | | U26IK606B : ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | U26IK606B.1 | - | - | - | - | - | 1 | - | 2 | 1 | 1 | - | - | - | - |
| CO2 | U26IK606B.2 | - | - | - | - | - | 1 | 1 | 2 | 1 | 1 | - | - | - | - |
| CO3 | U26IK606B.3 | - | - | - | - | - | 1 | - | 2 | 2 | 1 | - | 2 | - | - |
| CO4 | U26IK606B.4 | - | - | - | - | - | 1 | 1 | 2 | 2 | 1 | - | 2 | - | - |
| U26IK606B | | - | - | - | - | - | 1 | 1 | 2 | 1.5 | 1 | - | 2 | - | - |
| | | 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| CO | CO Statement<br>*The student should be able to…* | Relevant SDG | SDG Description | Mapping Justification |
| CO1 | 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 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. |

# POWER SEMICONDUCTOR DRIVES LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE607** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 :** determine the voltage and speed of single phase and three phase converter-controlled DC drives for different firing angles

**CO2 :** determine the voltage and speed of AC drives controlled by VSI, AC voltage controller & cycloconverter

**CO3 :** determine the voltage and speed of chopper-controlled DC drive for different duty cycles& speed characteristics ofinduction drives for varying loads

**CO4 :** simulate AC & DC drives using MATLAB-Simulink and draw the corresponding characteristics

**LIST OF EXPERIMENTS**

1. Speed control of single-phase fully converter-controlled DC drive
2. Speed control of single-phase semi converter-controlled DC drive
3. Speed control of three-phase fully/semi converter-controlled DC drive
4. Speed control of single phase VSI-PWM control AC drive
5. Speed control of single-phase AC voltage converter-controlled IM drive
6. Speed control of single phase cyclo-converter controlled IM drive
7. Four quadrant operation of chopper fed DC drive
8. Operation of buck converter-controlled DC drive
9. Rotor resistance control of wound rotor induction drive
10. Closed loop control of three-phase induction drive
11. Simulation of single-phase fully controlled converter DC drive using MATLAB-Simulink
12. Simulation of VSI controlled induction motor drive using MATLAB-Simulink

**Textbook(s):**

*1.* G.K. Dubey, *Fundamentals of Electrical Drives*, 2nd ed., New Delhi: Narosa Publishers, 1988

**Reference Book(S):**


1. Vedam Subrahmanyam, *Thyristor Control of Electrical Drives*, 2nd ed., New Delhi: McGraw Hill Education (India) Pvt. Ltd., 2017.
2. B.K. Bose, *Modern Power Electronics & A.C Drives*, New Delhi: Pearson edu. Pvt. Ltd., 2002.
3. P.S. Bimbhra, *Power Electronics*, 6th ed., New Delhi: Khanna Publishers, 2012.
4. N.K. De and P.K. Sen, *Electrical Drives*, New Delhi: Prentice Hall of India, 1999.


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

*Power Semiconductor Drives Laboratory Manual,* Department of EEE, KITSW

| **Course Articulation Matrix (CAM):** | | **U24EE607: POWER SEMICONDUCTOR DRIVES LABORATORY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE607.1** | 3 | 2 | 1 | 1 | 1 | - | - | 3 | 3 | 2 | 1 | 2 | 2 |
| **CO2** | **U24EE607.2** | 3 | 2 | 1 | 1 | 1 | - | - | 3 | 3 | 2 | 1 | 2 | 2 |
| **CO3** | **U24EE607.3** | 3 | 2 | 1 | 1 | 1 | - | - | 3 | 3 | 2 | 1 | 2 | 2 |
| **CO4** | **U24EE607.4** | 3 | 2 | 1 | 1 | 3 | 1 | - | 2 | 2 | 2 | 1 | 2 | 2 |
| **U24EE607** | | 3.0 | 2.0 | 1.0 | 1.0 | 1.0 | 1.0 | - | 2.75 | 2.75 | 2.0 | 1.0 | 2.0 | 2.0 |
| **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 voltage and speed of single phase and three phase converter-controlled DC drives for different firingangles | SDG9 | Industry, Innovation and Infrastructure | Converter-controlled DC drives improve efficient electrical energy utilization and support modern industrial automation systems |
| CO2 | determine the voltage and speed of AC drives controlled by VSI, AC voltage controller & cycloconverter | SDG9 | Industry, Innovation and Infrastructure | Efficient AC drive control techniques reduce energy losses and enable sustainable industrial operation. |
| CO3 | determine the voltage and speed of chopper-controlled DC drive for different duty cycles & speed characteristics of induction drives for varying loads | SDG9 | Industry, Innovation and Infrastructure | Chopper and induction motor drive control enhances energy-efficient speed regulation and industrial productivity |
| CO4 | simulate AC & DC drives using MATLAB-Simulink and draw the corresponding characteristics | SDG4 | Quality Education | Simulation-based learning develops modern engineering skills and supports innovation in industrial drive technologies |

# RENEWABLE ENERGY SYSTEMS LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE608** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 :** serve the variation of solar energy radiation &Sunshine with reference to time

**CO2 :** alyze the Performance character tics various PV devices and its series parallel Connections

**CO3 :** ses the Performance of Solar& Wind turbine System

**CO4 :** sign of storage system applications

1. Solar radiation measurement by using Solar Power Meter.
2. Performance evaluation of solar PV collector for series and parallel connection.
3. Effect of tilt angle on solar PV Panel.
4. Effect of Shading on solar PV Panel
5. Simulation of Stand-alone PV systems using Matlab -Simulink.
6. Simulation of Grid Connected PV systems using Matlab -Simulink.
7. Modeling and Simulation of wind turbine grid connection using Matlab –simulink.
8. Simulation of model of a variable pitch wind turbine using Matlab –Simulink.
9. Determine and plot the fuel flow rate, utilization, stack efficiency of Fuel cell stack model using MATLAB –Simulink
10. Plot the charging and discharging characteristics of Lithium-ion battery model using MATLAB - Simulink

**Textbook(s):**

1. Rai G.D, *Non-Conventional Energy Sources*, 4th ed. New Delhi: Khanna Publishers, 2010.

**Reference Book(S):**

1. Solanki ―Renewable Energy Technologies: Practical Guide For Beginneers‖, *PHI Learning Pvt. Ltd.*, 2008.
2. B.H. Khan, *Non-conventional Energy Resources*, 2nd ed. New Delhi: McGraw Hill Education (India) Pvt. Ltd., 2006.

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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ch40

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

*Manual for "Renewable Energy Systems Laboratory" prepared by the Department of EEE*

| **Course Articulation Matrix (CAM):** | | **U24EE608 : RENEWABLE ENERGY SYSTEMS LABORATORY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE608.1** | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 3 |
| **CO2** | **U24EE608.2** | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 3 |
| **CO3** | **U24EE608.3** | 3 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| **CO4** | **U24EE608.4** | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 |
| **U24EE608** | | 3 | 2.5 | 2 | 1 | 1.75 | 2.25 | 1 | 1 | 1 | 1 | 2 | 2.75 | 2.5 |
| **3 – HIGH, 2 – MEDIUM, 1 - LOW** | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | observe the variation of solar energy radiation &Sunshine with reference to time | SDG7 | Affordable and Clean Energy | Solar photovoltaic systems and renewable energy resource evaluation directly support affordable, reliable, sustainable, and clean energy generation. |
| CO2 | analyze the Performance character tics various PV devices and its series parallel Connections | SDG7 | Affordable and Clean Energy | Wind and geothermal energy technologies promote sustainable industrial innovation and development of modern renewable energy infrastructure. |
| CO3 | asses the Performance of Solar& Wind turbine System | SDG13 | Climate Action | Ocean and biomass energy systems reduce dependence on fossil fuels and contribute to mitigation of climate change through sustainable energy production. |
| CO4 | design of storage system applications | SDG12 | Responsible Consumption and Production | Efficient energy storage systems and fuel cell technologies promote sustainable energy utilization, efficient resource management, and cleaner production methods. |

# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE609** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 source code to load, preprocess, visualize, and analyze electrical engineering datasets using Python libraries and basic exploratory data analysis techniques.

**CO2 :** develop and evaluate supervised machine learning models for prediction and classification problems using appropriate performance metrics.

**CO3 :** develop source code to solve clustering, dimensionality reduction, and pattern classification problems using unsupervised learning models.

**CO4 :** develop end-to-end AI/ML solutions for Electrical Engineering applications by integrating data preprocessing, model training, performance evaluation, and intelligent decision-making techniques.

**Experiment-1 (UNIT-I)**

1. Develop a program to implement basic Python operations using NumPy and Pandas.
2. Develop a program to read, analyze, and visualize engineering datasets using Matplotlib.

**Experiment-2 (UNIT-I)**

1. Develop a program to perform data preprocessing techniques.
2. Develop a program to handle missing values, normalization, and feature scaling.

**Experiment-3 (UNIT-I)**

1. Develop a program to perform exploratory data analysis on electrical engineering datasets.
2. Develop a program to generate statistical summaries and correlation analysis.

**Experiment-4 (UNIT-II)**

1. Develop a program to implement Linear Regression for prediction applications.
2. Develop a program for energy/load forecasting using regression techniques.

**Experiment-5 (UNIT-II)**

1. Develop a program to implement Logistic Regression for classification problems.
2. Develop a program for binary classification using engineering datasets.

**Experiment-6 (UNIT-II)**

1. Develop a program to implement K-Nearest Neighbors (KNN) algorithm.
2. Develop a program to classify sensor or fault datasets using KNN.

**Experiment-7 (UNIT-III)**

1. Develop a program to implement Decision Tree algorithm.
2. Develop a program to implement Random Forest classifier.
3. Develop a program to compare classification performance metrics.

**Experiment-8 (UNIT-III)**

1. Develop a program to implement K-Means clustering algorithm.
2. Develop a program to cluster electrical or sensor datasets.

**Experiment-9 (UNIT-III)**

1. Develop a program to apply Principal Component Analysis (PCA) for dimensionality reduction.
2. Develop a program to visualize reduced-dimensional feature space.

**Experiment-10 (UNIT-IV)**

1. Develop a program to implement a basic Artificial Neural Network (ANN).
2. Develop a program to demonstrate forward propagation in neural networks.

**Experiment-11 (UNIT-IV)**

1. Develop a program to demonstrate back propagation and gradient descent optimization.
2. Develop a program to study the effect of epochs, learning rate, and hyperparameters on model performance.
3. Develop a program to analyze overfitting and underfitting conditions.

**Experiment-12 (UNIT-IV)**

1. Develop a program to implement an end-to-end AI/ML pipeline for Electrical Engineering applications.
2. Develop a program for predictive maintenance, renewable energy forecasting, load forecasting, or fault classification

**Textbook(s):**

1. Parteek Bhatia, *Machine Learning with Python*, Cambridge University Press, 2023.

**Reference Book(S):**

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media, 3rd edition, 2022.
2. Sebastian Raschka, Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 3rd edition, 2019.

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

*Artificial intelligence and Machine learning Laboratory Manual*, Department of EEE, KITSW

| **Course Articulation Matrix (CAM):** | | **U24EE609: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LABORATORY** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24EE609.1** | 3 | 2 | 2 | 1 | 3 | - | - | - | - | - | 1 | 1 | 2 |
| **CO2** | **U24EE609.2** | 3 | 3 | 2 | 2 | 3 | 1 | - | - | - | - | 1 | 2 | 2 |
| **CO3** | **U24EE609.3** | 3 | 3 | 3 | 2 | 3 | 1 | 1 | - | - | - | 1 | 2 | 3 |
| **CO4** | **U24EE609.4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 3 |
| **U24EE609** | | **3** | **2.75** | **2.5** | **2.0** | **3.0** | **1.25** | **1** | **1** | **1** | **1** | **1.25** | **2.0** | **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 | develop source code to load, preprocess, visualize, and analyze electrical engineering datasets using Python libraries and basic exploratory data analysis techniques. | **SDG 4** | Quality Education | the laboratory develops computational, analytical, and programming skills through hands-on implementation of AI/ML techniques, supporting quality technical education and digital competency development. |
| CO2 | develop and evaluate supervised machine learning models for prediction and classification problems using appropriate performance metrics. | **SDG 9** | Industry, Innovation and Infrastructure | supervised learning techniques such as regression, KNN, Decision Trees, and Random Forest support intelligent industrial systems, predictive analytics, automation, and smart infrastructure applications in Electrical Engineering. |
| CO3 | develop source code to solve clustering, dimensionality reduction, and pattern classification problems using unsupervised learning models. | **SDG 9** | Industry, Innovation and Infrastructure | Clustering and dimensionality reduction techniques enable intelligent monitoring, fault diagnosis, and data-driven automation systems that contribute to innovation in industrial and electrical engineering domains |
| CO4 | develop end-to-end AI/ML solutions for Electrical Engineering applications by integrating data preprocessing, model training, performance evaluation, and intelligent decision-making techniques. | **SDG 13** | Climate Action | AI/ML-based solutions for load forecasting, predictive maintenance, renewable energy monitoring, and smart energy management improve energy efficiency and support sustainable and reliable electrical systems. |

# TESTING AND MAINTENANCE OF AC MACHINES

| | | | |
|---|---|---|---|
| **Class:** B.Tech. VI -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE611X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-O-E):** | **2-0-2-0-4** | **CIE Marks (%):** | **60** |
| **Total Number of Teaching Hours:** | **32 Hrs** | **ESE Marks (%):** | **40** |

**Course Learning Objectives (LOs):**

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

**LO1**:Electrical machines operation and installations
**LO2**: Types of electrical AC machines and safety regulations
**LO3**: Electrical Tools for Testing and maintenances of AC machines
**LO4**: Testing methods used in electrical machines

| **UNIT-I** | **4 Hrs** |
|---|---|

**Fundamentals of Electrical machines and safety & Prevention of accidents:** Identify Definition of terminology used in safety, hazard, accident, responsibility, authority, accountability, monitoring, I.E Act & statutory regulations for safety of persons and equipment's working with electrical installation. Do and don'ts for substation operators as listed in IS Meaning and causes of electrical accidents factors and electrical shock. Procedure for rescuing the person from shocks. Methods for providing the artificial respiration, precaution to be taken to avoid fire due to electrical reasons, operation of fire extinguishers.

**General Introduction:** Objectives of testing significance of ISS concept of tolerance, routine tests, types of tests, special tests. Methods of Testing: Direct, Indirect, Regenerative. Concept of routine, preventive and breakdown of maintenance, advantages of preventive maintenance, procedure for developing preventive maintenance schedule, factors affecting preventive maintenance schedule and productive maintenance.

| **UNIT-II** | **4 Hrs** |
|---|---|

**Testing and Maintenance of Insulation:** classification of insulating materials as per IS 8504: part 3 1994. Factors affecting life of insulating materials. Measurement of insulation resistance, interpretation of condition of insulating. Methods of measuring temperature of internal parts of windings/machines and applying the correction factor when the machine is hot. Properties of good transformer oil, list the agents which contaminates the insulating oil. Understand the procedure of following test on oil as per IS 1692-1978 Acidity test, Sludge test, crackle test, flash point test. Filtration of insulating oil, protection of electrical equipment insulation during the period of inactivity. Methods of cleaning the insulation covered with loose, dry dust, stick dirt and oil viscous films. Procedure for cleaning washing and drying of insulation and Re-varnishing methods of internal heating and vacuum impregnation.

**Installation & Maintenance:** Factors involved in designing the machine foundation and Requirement of different dimensions of foundations for static and rotating machines. Procedure for levelling, alignment of two shafts directly & indirectly drives effects of misalignment. Installation of rotating machines as per IS 9001-1992. Use of various devices & tools in loading, unloading, lifting, carrying heavy equipment.

| **UNIT-III** | **4 Hrs** |
|---|---|

**Testing and maintenance of Transformers: T**ypes of tests, routine test, special tests as per IS 2026-1981 and procedure for conducting following tests: Measurement of winding resistance, No load losses & No load current, impedance voltage, load losses, Insulation resistance, Induced over voltage with stand test, separate source voltage withstand test, impulse voltage withstand test, temperature rise test of oil & winding. Different methods of determining temperature rise back to back test, short circuit test, open delta (Delta Delta test). Preventive & routine

maintenance of distribution transformer as per IS 10028:19881. Periodic checks for replacement of oil, silica gel. Parallel operation of Transformer and load sharing calculation.

**Testing and maintenance of rotating machines: T**ypes of tests, routine test, special tests of 1Ø & 3Ø induction motors, routine, preventive & breakdown maintenance of Induction motor as per ISO 9001:1992. Parallel operation of alternator, maintenance schedule of alternator as per IS 4884-1968.

**Testing of Synchronous Machine:** Alternators: Regulation testing using EMF, MMF, and ZPF methods. Synchronization: Tests for parallel operation of alternators. Synchronous Motors: V-curves and Inverted V-curves testing

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Maintenance of Electrical Machines & Condition Monitoring:** Scheduled maintenance, cleaning, lubrication, and visual inspection of AC/DC machines. **Insulation Testing:** Dielectric Strength, Megger testing, Polarization Index (PI) test, Tan-delta measurement. **Troubleshooting:** Common faults in motors/transformers and repair procedures. **Condition Monitoring:** Vibration analysis, Thermography, and Signature analysis of large motors. **Safety Procedures:** Safety guidelines for testing and maintenance, accident prevention, earthling practices.

**LABORATORY COMPONENT**

**List of Experiments**

1. Testing and measurement of circuit parameters using basic electrical instruments.
2. Installation and testing of energy meters.

**Textbook(s):**

1. *Testing and Maintenance of Electrical Machines by BP Patil*
2. Performance & Design of A.C. Machines – *M.G. Say.*

**Reference Book(S):**

1. Electrical Machines – *P.S. Bimbhra.*
2. Testing & Commissioning of Electrical Equipment – *S. Rao*

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

https://www.youtube.com/watch?v=mtO8xnvkCTY; *YOUTUBE Video lecture on* Testing & Maintenance of Electrical Machines I 6th Sem EE I Engineers Group

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

*Electrical machines Lab Manual and Record Book (LMRB),* 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 theory component)*

**CO1**: Understand the Indian electricity Act, safety rules, safety of machines and human
**CO2**: Know the procedure of testing of various electrical machines as per IS rules
**CO3**: Prepare maintenance schedule and troubleshooting chart for different equipment
**CO4**: know the procedure of different type of earthing as per need in electrical installation.

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

**CO5**: Study the prevention of electrical accident, safety measures and precaution
**CO6**: Installation of the distribution board & earthing with protective devices
**CO7**: Perform the loading, unloading and inspection of various electrical equipment as per standard procedure
**CO8**: test the performance of electrical instruments

| Course Articulation Matrix (CAM): | | U24EE211 ELECTRICAL WIRING (RESIDENTIAL) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
| CO1 | U24EE211.1 | 2 | 1 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO2 | U24EE211.2 | 2 | 2 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO3 | U24EE211.3 | 3 | 3 | 1 | 1 | 1 | | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO4 | U24EE211.4 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO5 | U24EE211.5 | 2 | 1 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO6 | U24EE211.6 | 2 | 2 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| CO7 | U24EE211.7 | 3 | 3 | 1 | 1 | 1 | | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO8 | U24EE211.8 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **U24EE211** | | **2.5** | **2.25** | **1** | **1** | **1** | **1** | **1** | **1** | **-** | **1** | **-** | **1** | **2** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | | |

# TESTING AND MAINTENANCES OF BATTERIES AND SOLAR CELL

| | | | |
|---|---|---|---|
| **Class:** B.Tech. VI -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE612X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-O-E):** | **2-0-2-0-4** | **CIE Marks (%):** | **60** |
| **Total Number of Teaching Hours:** | **32 Hrs** | **ESE Marks (%):** | **40** |

**Course Learning Objectives (LOs):**

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

**LO1**: Solar Cell & Photovoltaic (PV) Module Testing

**LO2**: Field Operation and Maintenance (O&M)

**LO3**: Battery Fundamentals and Testing and Fault Detection

**LO4**: Maintenance Procedures and Preventive maintenance

**THEORY COMPONENT**

| **UNIT-I** | **4 Hrs** |
|---|---|

**Solar Cell and Module Characterization:** Introduction to PV Technology, Current-Voltage and Power-Load characteristics. Spectral Response and Quantum Efficiency (QE) measurements. Electroluminescence (EL) and Photoluminescence (PL) imaging for defect detection. **Durability and Environmental Testing:** Potential Induced Degradation (PID) and Light Induced Degradation (LID) studies. Damp heat, thermal cycling, and humidity freeze tests.

**Solar Cell and PV Module Testing: Fundamental Principles:** Semiconductor physics, P-N junction, and solar radiation geometry. **Solar Cell Characteristics:** Measurement of current-voltage and (power-voltage) curves. **Performance Testing:** Efficiency measurements fill factor, dark and illumination characteristics. **Degradation and Failure Analysis:** Lifetime evaluation of PV modules, temperature effects, mismatch losses. **Environmental Standards:** Testing methods complying with IS/IEC standards

| **UNIT-II** | **4 Hrs** |
|---|---|

**Field Operation and Maintenance (O&M):** Measurement of PV module parameters: Voltage, Current, and Power calculation Performance testing: I-V curve plotting, measuring intensity of solar radiation is using pyranometers, Cleaning methods for modules (soiling management). Infrared (IR) thermography for hotspot detection. Testing of Charge Controllers, Inverters, and MPPT (Maximum Power Point Tracking). Safety procedures for array inspection and troubleshooting

**Solar PV System Maintenance- Installation & Field Level : System Components:** Connections and testing of battery banks, charge controllers, and inverters. **Field Performance:** Performance monitoring of PV power plants (IS/IEC 61724), data analysis, and optimization. **Troubleshooting:** Troubleshooting PV modules, inverters, and battery storage

| **UNIT-III** | **4 Hrs** |
|---|---|

**Battery Fundamentals and Testing and Fault Detection:** Types of batteries for PV systems: Lead-acid (vented/flooded, VRLA, AGM) and Lithium-ion. Battery parameters: Capacity, State of Charge (SOC), Depth of Discharge (DOD), Float voltage. Battery bank design: Series and parallel connections. Voltage testing: Open-circuit voltage measurement using a multimeter, Capacity testing: Load testing to determine battery health. Specific gravity testing: Using a hydrometer for flooded lead-acid batteries. Ohmic testing: Measuring internal battery resistance, Troubleshooting: Identifying dead cells, sulfation, and excessive corrosion.

**Battery Testing and Maintenance: Battery Technologies:** Working principles of Lead-Acid, Nickel-Cadmium, Nickel-Metal Hydride, Lithium-ion, and Zinc-Air batteries. **Battery**

**Parameters:** Capacity testing, state-of-charge (SOC), state-of-health (SOH), and voltage measurements. **Maintenance Practices:** Preventive and breakdown maintenance, cleaning of terminals, checking electrolyte levels, and safe disposal methods. **Advanced Diagnostics:** Electrochemical Impedance Spectroscopy (EIS), Cyclic Voltammetry (CV), and Battery Management Systems (BMS).

| **UNIT-IV** | **5 Hrs** |
|---|---|

**Maintenance Procedures:**

**Preventive maintenance**: Cleaning battery terminals, checking connections. **Electrolyte maintenance:** Checking water levels and adding distilled water. **Equalization:** Equalizing charge to ensure uniform cell voltage. **Safety protocols:** Handling acid, personal protective equipment (PPE), and disposal of used.

**Balance of Systems (BoS) Maintenance: Charge Controller:** Testing solar charge controllers (PWM vs. MPPT), **Inverter:** Troubleshooting inverter faults and maintenance. **Safety & Regulatory:** Earth testing and lightning protection inspection

**LABORATORY COMPONENT**

**List of Experiments**

1. Testing and measurement of circuit parameters using basic electrical instruments.
2. Installation and testing of energy meters.

**Textbook(s):**

1. Solar Photovoltaic: Fundamental, Technology and Application by Chetan singh Solanki
2. Photovoltaic system Engineering *by Roger A Messenger and Jerry*

**Reference Book(S):**

1. Testing & Commissioning of Electrical Equipment – *S. Rao*

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

https://www.youtube.com/watch?v=HQ4SfbeGg5s; *YOUTUBE Video lecture on* Testing & Maintenance of Complete Solar Panel Connection with Solar Charge Controller and Inverter

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

1. Electrical machines Lab Manual and Record Book (LMRB), 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 theory component)*

**CO1**: Understand the basics of power and Energy calculation in SPV system.
**CO2**: Interpret the parameters of PV modules and their connection to form array & MPPT
**CO3**: Battery Fundamentals and Testing and Fault Detection and its Technology
**CO4**: know the Maintenance Procedures and Balance of Systems (BoS)

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

**CO5**: know types of Batteries and their necessity for solar PV system
**CO6**: Battery Testing and Maintenance
**CO7**: Preventive maintenance and safety protocols
**CO8**: Maintenance Practices and advanced Diagnostics

| **Course Articulation Matrix (CAM):** | | **U24EE211X ELECTRICAL WIRING (RESIDENTIAL)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO 1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO 7** | **PO 8** | **PO 9** | **PO 10** | **PO 11** | **PO 12** | **PSO1** | **PSO 2** |
| **CO1** | **U24EE211X.1** | 2 | 1 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO2** | **U24EE211X.2** | 2 | 2 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO3** | **U24EE211X.3** | 3 | 3 | 1 | 1 | 1 | | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO4** | **U24EE211X.4** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO5** | **U24EE211X.5** | 2 | 1 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO6** | **U24EE211X.6** | 2 | 2 | - | - | - | - | - | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO7** | **U24EE211X.7** | 3 | 3 | 1 | 1 | 1 | | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO8** | **U24EE211X.8** | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **U24EE211X** | | **2.5** | **2.25** | **1** | **1** | **1** | **1** | **1** | **1** | **-** | **1** | **-** | **1** | **2** | **1** |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | | |

# INTRODUCTION TO CONTROL OF ELECTRIC VEHICLE

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI–Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE613X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-E):** | **2-0-2-3** | **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 :** classify EVs and compute energy consumption

**CO2 :** analyse electric propulsion systems and motor control techniques used in EVs

**CO3 :** analyze battery management systems and charging methods

**CO4 :** Compare driving cycle and energy management strategies of EVs

| **UNIT-I** | **4 Hrs** |
|---|---|

**Introduction to Electric Vehicles and Vehicle Dynamics:**
History and evolution of Electric Vehicles (EVs), Classification of EVs: BEV, HEV, PHEV and FCEV, Comparison between conventional vehicles and electric vehicles, Components of EVs and block diagram representation
**Vehicle Dynamics:** tractive force, rolling resistance, aerodynamic drag and gradient resistance and energy consumption calculations.

| **UNIT-II** | **4 Hrs** |
|---|---|

**Electric propulsion systems:** Selection criteria of electric motors for EV applications, Construction, operation and characteristics of DC motors, BLDC motors, PMSM and Induction Motors used in EVs
**EV Motor Drives:** Introduction to power electronic converters for EV, Speed and torque control techniques of EV motors, Regenerative braking, control and applications

| **UNIT-III** | **4 Hrs** |
|---|---|

**Batteries in electric vehicles:** Lead-acid, NiMH, Lithium-ion batteries and super capacitors, Battery parameters and characteristics
**Battery Management System (BMS):** functions and protection methods, State of Charge (SOC) and State of Health (SOH) estimation
**EV charging methods:** AC charging, DC fast charging and wireless charging, Introduction to charging standards and charging infrastructure

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Control of Electric Vehicles and Applications:** control architecture of electric vehicles, Drive cycle analysis and energy management strategies, Electronic Control Unit (ECU) and sensors used in EVs, Control of acceleration, braking and traction systems,

**Intelligent transportation systems and autonomous EV**: concepts, Safety standards and future trends in electric vehicle technology and applications

**Textbook(s):**


1. James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley Publications. 2nd ed., 2012


**Reference Book(S):**


1. C. Mi, M. A. Masrur and D. W. Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons, 2nd ed., November 2017.
2. S. Onori, L. Serrao and G. Rizzoni, Hybrid Electric Vehicles: Energy Management Strategies, Springer, 1st ed., 2016.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 1st ed., 2005.
4. T. Denton, Electric and Hybrid Vehicles, Taylor & Francis Group, 1st ed., 2016.


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

- https://www.youtube.com/watch?v=UgtjRob5qMg&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr NPTEL Course on Fundamentals of Electric Vehicles: Technology & Economics

| Course Articulation Matrix (CAM): U24EE613X: Introduction to Control of Electric Vehicles | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE613X.1 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| CO2 | U24EE613X.2 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| CO3 | U24EE613X.3 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| CO4 | U24EE613X.4 | 1 | 2 | 2 | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| U24EE613X | | **1** | **2** | **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 | classify EVs and compute energy consumption | SDG11 | Sustainable Cities and Communities | Understanding electric vehicles and vehicle dynamics supports the development of sustainable transportation systems and eco-friendly urban mobility solutions. |
| CO2 | analyse electric propulsion systems and motor control techniques used in EVs | SDG7 | Affordable and Clean Energy | Efficient electric propulsion systems and motor control techniques improve energy utilization and promote clean and sustainable transportation technologies. |
| CO3 | analyze battery management systems and charging methods | SDG12 | Responsible Consumption and Production | Advanced battery technologies and energy management methods encourage efficient energy storage, optimized charging, and sustainable utilization of resources. |
| CO4 | Compare driving cycle and energy management strategies of EVs | SDG13 | Climate Action | Electric vehicle control strategies and performance optimization help reduce carbon emissions and support environmentally sustainable transportation systems. |

# INTRODUCTION TO HYBRID ELECTRIC VEHICLE USING MATLAB AND SIMULINK

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24SE611X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-E):** | **2-0-2-4** | **CIE Marks (%):** | **60** |
| **Total Number of Teaching Hours:** | **32 Hrs** | **ESE Marks (%):** | **40** |

**Course Learning Outcomes (COs)**

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

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

**CO1 :** analyse diverse hybrid electric vehicle (HEV) powertrain topologies and drive cycles

**CO2 :** develop equivalent circuit models for energy storage and state-of-charge estimation

**CO3 :** model internal combustion engines, electric drives, and power electronic converters

**CO4 :** design supervisory energy management control strategies using state flow-based logic

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

**CO1 :** build and simulate vehicle longitudinal dynamics models in MATLAB/Simulink

**CO2 :** implement state-of-charge estimation blocks and battery thermal models

**CO3 :** configure power electronic converter models and motor drives using Simscape

**CO4 :** evaluate full-scale system performance of an HEV over standard drive cycles

| **UNIT-I** | **4 Hrs** |
|---|---|

**HEV Architectures and Drive Cycles:** Environmental impact and evolution of hybrid vehicles; classification of HEV architectures (Series, Parallel, Series-Parallel configurations); power flow pathways during acceleration, braking, and cruising; longitudinal vehicle dynamics (aerodynamic drag, rolling resistance, grading resistance); introduction to standard drive cycles and implementation in MATLAB

| **UNIT-II** | **4 Hrs** |
|---|---|

**Battery Modelling and Energy Storage:** Battery chemistry selection criteria (Li-ion, NiMH); Equivalent Circuit Modelling (ECM) techniques (Rint model, RC networks); implementing battery parameter variation with Temperature and SOC; state-of-charge estimation using Coulomb counting; implementation of battery management blocks in Simulink

| **UNIT-III** | **4 Hrs** |
|---|---|

**Powertrain Component Modelling:** Modelling of Internal Combustion Engines (ICE) via Brake Specific Fuel Consumption (BSFC) look-up maps; modelling electric drives (PMSM and Induction Motors) using Simscape Electrical; modelling power electronic networks (DC-DC converters and DC-AC inverters); configuration of planetary gear units and mechanical torque splitters

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Control Strategies and Energy Management:** Principles of vehicle supervisory control; rule-based energy management systems (EMS) using deterministic logic; Stateflow state-machine implementation for operational mode switching; fundamentals of regenerative braking and blending control with friction brakes; tracking driver commands using Proportional-Integral (PI) speed controllers

## LABORATORY COMPONENT

**List of Experiments:**

1. Introduction to Simscape Electrical and modelling simple physical components in Simulink.
2. Modelling longitudinal vehicle resistances (aerodynamic drag, rolling resistance) to calculate power demand.
3. Importing and simulating standard driving cycles (WLTP and FTP-75) using signal builder blocks.
4. Designing a battery equivalent circuit model (Rint) and validating voltage-current characteristics.
5. Implementing a Coulomb counting algorithm in Simulink for continuous State of Charge (SOC) tracking.
6. Simulating a Permanent Magnet Synchronous Motor (PMSM) drive loop under varying torque profiles.
7. Modelling and controlling a bi-directional DC-DC buck-boost converter for battery charging/discharging.
8. Developing a rule-based mode selector for a Series hybrid vehicle using Stateflow charts.
9. Simulating a regenerative braking control subsystem and calculating energy recovery metrics.
10. Integrating a full Series-Parallel HEV powertrain model and optimizing fuel economy over a drive cycle

**Textbook(s):**

1. Iqbal Husain, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press Publishers, 3rd edition, 2021.
2. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, CRC Press Publishers, 3rd edition, 2018.

**Reference Book(S):**

1. Amir Khajepour, Saber Fallah, Avesta Goodarzi, *Electric and Hybrid Vehicles: Technologies, Modelling and Control: A Mechatronic Approach*, Wiley Publishers, 2014.
2. *Simscape Electrical User's Guide*, The MathWorks, Inc.

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

*MATLAB & Simulink Robotics and Automotive Video Lecture series on Powertrain Blockset by Mr. Mile Sasena, Automotive Product Manager, MathWorks.*

**Laboratory Manual:**

*Hybrid Electric Vehicle Modelling and Simulation Lab Manual, Department of EEE.*

| Course Articulation Matrix (CAM): | | U24SE611X : INTRODUCTION TO HYBRID ELECTRIC VEHICLE USING MATLAB AND SIMULINK | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24SE611X.1 | 2 | 2 | 1 | - | 2 | - | - | 2 | 1 | 1 | 1 | 2 | 2 |
| CO2 | U24SE611X.2 | 2 | 2 | 2 | 1 | 2 | - | - | 2 | 1 | 1 | 1 | 2 | 2 |
| CO3 | U24SE611X.3 | 3 | 3 | 2 | 1 | 3 | - | - | 2 | 1 | 1 | 1 | 3 | 2 |
| CO4 | U24SE611X.4 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 2 |
| CO5 | U24SE611X.5 | 2 | 2 | 1 | 1 | 3 | - | - | 2 | 1 | 1 | 1 | 2 | 2 |
| CO6 | U24SE611X.6 | 2 | 2 | 2 | 1 | 3 | - | - | 2 | 1 | 1 | 1 | 2 | 2 |
| CO7 | U24SE611X.7 | 3 | 3 | 2 | 2 | 3 | - | - | 2 | 1 | 1 | 1 | 3 | 2 |
| CO8 | U24SE611X.8 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 3 | 2 |
| U24SE611X | | 2.63 | 2.50 | 2.00 | 1.43 | 2.75 | 1.00 | 1.00 | 1.00 | 2.00 | 1.00 | 1.00 | 2.50 | 2.00 |
| 3 – HIGH, 2 – MEDIUM, 1 – LOW | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | analyze diverse hybrid electric vehicle (HEV) powertrain topologies and drive cycles. | **SDG 11** | Sustainable Cities and Communities | Evaluates alternative low-emission vehicle layouts and standardized drive cycles to reduce urban transportation emissions and air pollution. |
| CO2 | develop equivalent circuit models for energy storage and state-of-charge estimation. | **SDG 7** | Affordable and Clean Energy | Models battery storage and precision tracking systems to maximize energy extraction efficiency and enhance battery lifespan. |
| CO3 | model internal combustion engines, electric drives, and power electronic converters. | **SDG 9** | Industry, Innovation and Infrastructure | Drives automotive technical innovation by sizing and integrating optimized power electronics, high-efficiency motor drives, and advanced powertrains. |
| CO4 | design supervisory energy management control strategies using stateflow-based logic. | **SDG 12** | Responsible Consumption and Production | Implements optimal rule-based control logic to minimize fossil fuel consumption and maximize resource efficiency during operational driving modes. |

# INSTALLATION OF SOLAR PV PANEL

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24SE612X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-E):** | **2-0-2-4** | **CIE Marks (%):** | **60%** |
| **Total Number of Teaching Hours:** | **32 Hrs** | **ESE Marks (%):** | **40%** |

**Course Learning Outcomes (COs)**

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

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

**CO1 :** design solar string configurations using appropriate modules and accessories

**CO2 :** apply solar installation safety standards and regulations in designing system layouts

**CO3 :** identify suitable tools and testing equipment used for solar PV installations

**CO4 :** calculate load sizing metrics and suggest appropriate commissioning tests for solar installations

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

**CO1 :** install and perform electrical wiring of DC strings and AC power components

**CO2 :** demonstrate the installation of distribution boxes, charge controllers, and grounding protection systems

**CO3 :** install the electrical balance-of-system with dynamic solar protection devices

**CO4 :** test the performance of complete solar PV installations using electrical measurement instruments

| **UNIT-I** | **4 Hrs** |
|---|---|

**Fundamentals of Solar PV Technology:** Identify various types of solar PV cells (Monocrystalline, Polycrystalline, Thin-film) and modules; understand the photovoltaic effect, solar irradiance, and peak sun hours; analyse panel electrical parameters from datasheets

| **UNIT-II** | **4 Hrs** |
|---|---|

**Solar Site Assessment & Regulations:** Overview of solar installations in residential, commercial, and industrial settings; importance of electrical/mechanical safety standards and local net-metering regulations; principles of shading analysis, orientation, tilt angle optimization, and voltage drop minimization

| **UNIT-III** | **4 Hrs** |
|---|---|

**Solar Tools and Equipment:** Identification and proper use of solar-specific tools (MC4 crimping pliers, wire strippers, torque wrenches); measurement tools: Multimeter, Clamp meter, Irradiance meter (Pyranometer); safety equipment: High-altitude safety harnesses, insulated gloves, goggles, safety shoes

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Solar PV Sizing & Wiring Systems:** Wiring methods for series, parallel, and series-parallel string layouts; selection and sizing of DC/AC cables, conduits, inverters, and charge controllers; installation of array junction boxes, distribution boards, and grounding infrastructure; basic system sizing load calculations; inspection and testing of solar PV installations

## LABORATORY COMPONENT

**List of Experiments:**

**1.** Measurement of open-circuit voltage and short-circuit current of a solar PV module.

2. Analysing the effect of shading and tilt angle on the power output of solar panels.
3. Wiring and installation of solar panels in series and parallel configurations.
4. Connection and testing of solar panels with a solar charge controller and battery bank.
5. Simulation of Stand-alone PV systems using MATLAB -Simulink.
6. Simulation of Grid Connected PV systems using MATLAB -Simulink.
7. Modelling and Simulation of wind turbine grid connection using MATLAB –Simulink.
8. Simulation of model of a variable pitch wind turbine using MATLAB –Simulink.
9. Determine and plot the fuel flow rate, utilization, stack efficiency of Fuel cell stack model using MATLAB –Simulink.
10. Plot the charging and discharging characteristics of Lithium-ion battery model using MATLAB - Simulink.

**Textbook(s):**

1. Chetan Singh Solanki, *Solar Photovoltaics: Fundamentals, Technologies and Applications*, PHI Learning Pvt. Ltd., 3rd edition, 2015, New Delhi.

**Reference Book(S):**

1. Sean White, *Solar Photovoltaic Basics: A Study Guide for the NABCEP Associate Exam*, Routledge Publications, 2nd edition, 2018, USA.
2. Dunlop, J. P., *Photovoltaic Systems*, American Technical Publishers, 3rd edition, 2012, USA.

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

*www.youtube.com; YOUTUBE Video lecture on Solar PV System Installation Basics*

**Laboratory Manual:**

*Solar Photovoltaic Installation Lab Manual and Record Book (LMRB), Department of EEE, KITSW.*

| **Course Articulation Matrix (CAM):** | | **U24SE612X : INSTALLATION OF SOLAR PV PANEL** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24SE612X.1** | 2 | 1 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO2** | **U24SE612X.2** | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO3** | **U24SE612X.3** | 3 | 3 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO4** | **U24SE612X.4** | 3 | 3 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO5** | **U24SE612X.5** | 2 | 1 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO6** | **U24SE612X.6** | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO7** | **U24SE612X.7** | 3 | 3 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **CO8** | **U24SE612X.8** | 3 | 3 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **U24SE612X** | | 2.5 | 2.25 | 2 | 1 | 2 | 1 | - | 1 | 1 | 1 | 1 | 2 | 2 |
| **3 – HIGH, 2 – MEDIUM, 1 – LOW** | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | analyse systems of electric traction, traction motors, and compute specific energy consumption for different speed-time curves | SDG11 | Sustainable Cities and Communities | Evaluates specific energy consumption (SEC) to lower urban transit carbon output, and targets clean, efficient city-wide public transport networks. |
| CO2 | identify suitable drives for industrial applications | SDG9 | Industry, Innovation and Infrastructure | Covers specialized industrial operations including paper, textile, and cement manufacturing. Optimizes electric motor drive configurations for heavy industrial machinery. |
| CO3 | design circular and ribbon type heating element and describe the welding techniques | SDG9 | Industry, Innovation and Infrastructure | Implements precise control via induction, arc, and dielectric heating methods. Minimizes manufacturing raw-material loss and thermal waste during processing. |
| CO4 | design of lighting scheme and lighting calculation for a given surface and determine the power correction for a typical system | SDG7 | Affordable and Clean Energy | Integrates energy-efficient light sources, including modern LED and fluorescent lamps, and enhances power factors to mitigate unnecessary transmission line power losses |

# FAULT DETECTION AND TROUBLESHOOTING OF INVERTER, STABILIZER, UPS AND BATTERY CHARGER

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VI–Semester | | **Branch:** EEE | |
| **Course Code:** | **U24SE613X** | **Credits:** | **3** |
| **Hours/Week (L-T-P-E):** | **2-0-2-3** | **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 :** understand the fundamentals, operation and applications of power conditioning equipment such as inverters, stabilizers, UPS systems and battery chargers.

**CO2 :** analyze inverter and stabilizer circuits, identify common faults and perform troubleshooting of associated components and control circuits.

**CO3 :** understand the operation of UPS systems and battery chargers, diagnose faults and troubleshoot charging and protection circuits.

**CO4 :** apply preventive maintenance, testing methods and electrical safety practices for servicing inverter, UPS, stabilizer and battery charger systems.

| **UNIT-I** | **4 Hrs** |
|---|---|

**Fundamentals of Power Conditioning Equipment:** Introduction to power conditioning equipment, Need and applications of inverters, stabilizers, UPS systems and battery chargers, Types and specifications of inverters, Principle of operation of voltage stabilizers and UPS systems, Types of batteries used in UPS and inverter systems, Block diagram and working principles of battery chargers

| **UNIT-II** | **4 Hrs** |
|---|---|

**Inverter Fault Detection:** Common faults in inverter systems: no output, low output voltage, overheating, switching device failure and transformer faults

**Stabilizer Fault Detection:** Stabilizer circuits and voltage regulation methods. Common stabilizer faults and troubleshooting procedures, Testing of relays, transformers, MOSFETs, IGBTs and control circuits

| **UNIT-III** | **4 Hrs** |
|---|---|

**UPS Troubleshooting:** Common UPS faults, Battery backup failure, overload condition, charger faults, inverter section faults and alarm indications

**Battery Charger Troubleshooting:** Battery charger circuits and charging methods, troubleshooting of rectifier circuits, charging controllers and battery protection systems

| **UNIT-IV** | **4 Hrs** |
|---|---|

**Maintenance, Testing:** Preventive maintenance techniques for inverter, stabilizer, UPS and battery charger systems, Use of measuring instruments for servicing applications, PCB testing and component identification, Soldering and desoldering techniques

**Safety Practices:** Electrical safety precautions and earthling practices, Introduction to service manuals and fault diagnosis flowcharts, Emerging trends in smart UPS and inverter systems

**Textbook(s):**


1. Muhammad H. Rashid, Power Electronics: Circuits, Devices and Applications, Pearson Publications, 4th ed., 2017
2. James Larminie and John Lowry, Electric Vehicle Technology Explained Wiley Publications, 2nd ed.,2012


**Reference Book(S):**


1. Ali Emadi, Uninterruptible Power Supplies and Active Filters, CRC Press, 1st ed.,2004
2. John G. Kassakian, Martin F. Schlecht, George C. Verghese, Pearson Publications, 2nd ed., 1991
3. Paul Gill, Electric Power Systems Maintenance and Testing, CRC Press, 2nd ed.,2008


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

https://www.youtube.com/watch?v=3oq18dZmb3Q, **UPS ,Troubleshooting & Repair, UPS Backup Problem**

| Course Articulation Matrix (CAM): | | U24SE613X : Fault Detection and Troubleshooting of Inverter, Stabilizer, UPS and Battery Charger | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24SE613X.1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| CO2 | U24SE613X.2 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| CO3 | U24SE613X.3 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| CO4 | U24SE613X.4 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | 1 |
| U24SE613X | | **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, operation and applications of power conditioning equipment such as inverters, stabilizers, UPS systems and battery chargers | SDG7 | Affordable and Clean Energy | Power conditioning equipment improves power quality, energy efficiency and reliable utilization of electrical energy in domestic and industrial applications. |
| CO2 | Analyze inverter and stabilizer circuits, identify common faults and perform troubleshooting of associated components and control circuits | SDG9 | Industry, Innovation and Infrastructure | Troubleshooting and maintenance of inverter and stabilizer systems support reliable electrical infrastructure and industrial automation systems. |
| CO3 | Understand the operation of UPS systems and battery chargers, diagnose faults and troubleshoot charging and protection circuits | SDG12 | Responsible Consumption and Production | Efficient operation and maintenance of UPS and battery charging systems promote optimal energy utilization and longer equipment life, reducing electronic waste. |
| CO4 | Apply preventive maintenance, testing methods and electrical safety practices for servicing inverter, UPS, stabilizer and battery charger systems | SDG13 | Climate Action | Preventive maintenance and efficient servicing practices reduce energy losses, improve equipment efficiency and support environmentally sustainable electrical systems. |

## VII SEMESTER

| S. No. | Category | Course Code | Course Title | Lectures / week | | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | C |
| 1 | OEC | U24OE701X -SDG | Open Elective –SDG | 2 | 1 | - | 3 | 3 |
| 2 | PEC | U24EE702 | Program Elective - II/ MOOCs-II | 2 | 1 | - | 3 | 3 |
| 3 | PCC | U24EE703 | Power System Operation and Control | 2 | 1 | | 3 | 3 |
| 4 | PCC | U24EE704 | Switchgear and Protection | 2 | 1 | - | 3 | 3 |
| 5 | PCC | U24EE705 | Electric Vehicles | 2 | 1 | - | 3 | 3 |
| 6 | PCC | U24EE706 | Power System Laboratory | - | - | 2 | 2 | 1 |
| 7 | PCC | U24EE707 | Electrical Simulation Laboratory | - | - | 2 | 2 | 1 |
| 8 | ELC | U24EE708 | Internship Evaluation | - | - | 2 | 2 | 1 |
| 9 | ELC | U24EE709 | Major Project Phase-1 / Industrial Internship -1 | - | - | 8 | 8 | 4 |
| Total: | | | | 10 | 5 | 14 | 29 | 22 |
| Additional Learning@:Maximum credits allowed for Honours/Minor | | | | - | - | - | - | 4 |
| Total credits for Honours/Minor students: | | | | - | - | - | - | 26 |

| Pool - XIX<br>Sustainable Development Goals Basket (OE - SDGB) | | |
|---|---|---|
| . No. | Course Code | Course Title |
| 1. | **U24OE701A-SDG** | *Sustainable waste management and circular economy* -offered by CE |
| 2. | **U24OE701B-SDG** | *Sustainable Heat and Energy Engineering* - offered by ME |
| 3. | **U24OE701C-SDG** | *Sensors And Actuators for Sustainable Smart Cities And Health Care* -offered by ECI |
| 5. | **U24OE701Z-SD** | Any other course approved by BoS Chair and Dean AA |

# SUSTAINABLE WASTE MANAGEMENT AND CIRCULAR ECONOMY

| Class: B. Tech. VII – Semester | | Branch: CE | |
|---|---|---|---|
| Course Code: | **U24OE701A-SDG** | Credits: | 3 |
| Hours/Week (L-T-P- E): | 2-1-0-3 | CIE: | 60% |
| Total No of Teaching Hours: | 36 Hrs | ESE: | 40% |

**Course Learning Outcomes (COs)**

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

**CO1:** appraise the concept of waste management

**CO2 :** analyze activities associated with the management of hazardous wastes

**CO3:** apply the concept of circular economy and conduct relevant research

**CO4:** create business models for sustainable development using complex aspects of circular economy.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Waste management:** Introduction, context and overview of waste management, waste landscape in India, hierarchy of waste management, sources of waste and waste streams, challenges and opportunities in waste management.

**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 responsibilities of various sectors, supporting initiatives of public and private domains,
international recommendations and mandates.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Elements of Hazardous waste management:** Hazardous waste definition, sources, identification and classification, Collection, handling, storage and transport, Hazardous waste management rules and regulations, treatment technologies, Hazardous waste disposal, Hazardous waste landfills- Site selections, design and operation. Hazardous waste reduction, recycling and reuse, remediation of hazardous waste contaminated sites.

**Management of different Hazardous waste:**
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** | **9 Hrs** |
|---|---|

**Introduction to Circular Economy**: Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy.
**Characteristics of Circular Economy:** Material recovery, waste reduction, reducing negative externalities, explaining butterfly diagram, concept of loops.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Circular design, innovation and Assessment**: Zero waste- Waste Management in context of Circular Economy, Circular design, Research and innovation, Life Cycle Assessment (LCA), Circular Business Models

**Case Studies and Legal policy framework** Business models, Solid Waste Management / Wastewater, Plastics: A case study, EPR: polluters pay principle, Industrial symbiosis/ Eco-parks, Role of governments and networks, Sharing best practices, Universal circular economy policy goals, India and CE strategy, ESG

**Textbook(s):**

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-United Nations Institute for Training and Research-2013-*ISBN: 978-*

*92-807-3333-4*
2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition.
3. Integrated Solid Waste Management, Engineering Principles and Management Issues, Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition

**Reference Book(S):**

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-United Nations Institute for Training and Research-2013-ISBN: 978-92-807-3333-4
2. National Waste Management Strategy 2020- Minister of Forestry, Fisheries and the Environment, Republic of South Africa
3. Circular Economy: A Credit Point Course, Proposed by International Council for Circular Economy (ICCE) New Delhi, In Collaboration with All India Council for Technical Education (AICTE) New Delhi.
4. The Circular Economy A User's Guide Walter R Stahel Routledge; 1st Edition (24 June 2019)
5. Circular Economy: (Re) Emerging Movement Shalini Goyal Bhalla Invincible Publisher
6. The Circular Economy Handbook: Realizing The Circular Advantage Peter Lacy, Jessica Long, Wesley Spindler Palgrave Macmillan UK
7. Waste to Wealth: The Circular Economy Advantage Peter Lacy, Jakob Rutqvist Palgrave Macmillan

**Web and Video link(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-Waste Strategies, India CE Policy Framework) by Prof. Brajesh Kumar Dubey, IIT Kharagpur.*

| Course Articulation Matrix (CAM): | | U24OE701A-SDG SUSTAINABLE WASTE MANAGEMENT AND CIRCULAR ECONOMY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24OE701A-SDG.1 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | - | 1 | 1 | 2 | 1 |
| CO2 | U24OE701A-SDG.2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| CO3 | U24OE701A-SDG.3 | 2 | 2 | 2 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| CO4 | U24OE701A-SDG.4 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| U24OE701A-SDG | | 2 | 1.25 | 1.25 | 1 | 2 | 1 | 1 | 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 | appraise the concept of waste management | SDG 12 | Responsible Consumption and Production | Appraising the waste management hierarchy, National Waste Management Strategies (NWMS), and policy tools for controlling waste streams directly promotes responsible consumption, sustainable production patterns, and significant reduction of waste generation across municipal, industrial, and hazardous waste sectors. |
| CO2 | analyze activities associated with the management of hazardous wastes | SDG 11 | Sustainable Cities and Communities | Analyzing collection, handling, treatment, landfill design, and regulatory compliance for hazardous wastes — including plastic, biomedical, e-waste, and nuclear waste — safeguards human health and environmental quality, contributing to the development of safe, resilient, and environmentally sustainable urban and industrial communities. |

| | | | | |
|---|---|---|---|---|
| CO3 | apply the concept of circular economy and conduct relevant research | SDG 9 | Industry, Innovation and Infrastructure | Applying circular economy principles — material recovery, waste reduction, LCA, butterfly diagram, and loop strategies — and conducting innovation-driven research fosters sustainable industrial practices that decouple economic growth from resource depletion, supporting resilient and environmentally responsible industrial infrastructure. |
| CO4 | create business models for sustainable development using complex aspects of circular economy. | SDG 9 | Industry, Innovation and Infrastructure | Creating circular business models — incorporating EPR, industrial symbiosis, eco-parks, zero-waste strategies, ESG frameworks, and India-specific CE policy goals — drives innovation-led, resource-efficient industry and contributes to inclusive, sustainable economic growth aligned with SDG 9 and the global circular economy agenda. |

# SUSTAINABLE HEAT AND ENERGY ENGINEERING

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VII – Semester | | **Branch:** | |
| **Course Code:** | **U24OE701B-SDG** | **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: differentiate heat and work, and evaluate energy transfer in closed systems for sustainable energy management.*

*CO2: assess the performance of thermodynamic devices using SFEE and second-law principles for energy efficiency and sustainability.*

*CO3: classify sustainable and renewable energy sources, including solar, hydrogen, and other non-conventional technologies.*

*CO4: analyze sustainable energy conversion technologies such as MHD, thermoelectric, thermionic systems, and biogas generation.*

| **UNIT-I** | **9 Hrs** |
|---|---|

**Fundamental Concepts:** Introduction, units, types of systems, control volume, control mass, continuum, macroscopic and microscopic point of view thermodynamics, Thermodynamic state, property, process, cycle, Intensive and extensive properties; Heat and Work, Thermodynamic Equilibrium, point and path functions, cyclic process, reversibility, quasi static process, irreversible process, Zeroth law of Thermodynamics and its applications

**Principles of Energy Conservation and Sustainability:** Statement of First Law, applications to closed systems- internal energy, enthalpy and specific heats; Processes of closed system-constant volume, constant pressure, isothermal, adiabatic and polytropic; P-V-T relations, Perfect and real gases, Joule-Thomson coefficient, inversion curve, Vander walls equation of state

| **UNIT-II** | **9 Hrs** |
|---|---|

**Open System Energy Balance for Sustainability:** Steady Flow Energy Equation (SFEE); applications to thermodynamic devices- boiler, turbine, nozzle, compressor, pump, heat exchangers

**Second Law Principles for Sustainable Development:** Limitations of the first law of thermodynamics, Kelvin-Planck Statement, Clausius statement, Equivalence of Kelvin and Clausius Statements, Heat engine, Heat pump, Refrigerator, relation between COP of Heat pump and Refrigerator, Reversibility, Irreversibility, Causes of irreversibility, Conditions for reversibility, Carnot cycle, Carnot theorem, Thermodynamic temperature scales

| **UNIT-III** | **9 Hrs** |
|---|---|

**Introduction**: Classification of energy sources; distinction between conventional and non-conventional sources of energy; present energy scenario in India

**Solar Energy and Green Sustainability**: Introduction; solar constant; solar radiation on the earth's surface; solar radiation geometry; solar radiation measuring devices- pyrheliometer, pyranometer, sunshine recorder; Solar thermal energy collectors – liquid flat plate, air heaters, collectors with booster mirrors and concentrating collectors, applications of solar thermal collectors - absorption air conditioning system, thermal water pump, furnace, chimney, distillation, pond and cooker; solar energy storage systems–thermal, sensible and latent heat

**Green Hydrogen for a Sustainable Future**: Basics of hydrogen energy, production methods, storage, transportation, and applications

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Magneto Hydro Dynamic (MHD) Power Generation for Sustainable Energy**: Open and closed MHD systems; design problems and developments, advantages

**Sustainable Thermoelectric and Thermionic Energy Conversion**: Thermoelectric effects; principle of thermoelectric power generation and thermo-ionic converter, applications

**Sustainable Bioenergy Systems**: Biomass conversion technologies - wet and dry processes; photosynthesis; biogas generation, classification of biogas plants, biogas from plant wastes, site selection for a gas plant; digester design considerations, methods for maintaining biogas production; utilization of biogas; biomass gasification - classification and applications of gasifiers

**Textbook(s):**

1. Nag P.K., *Engineering Thermodynamics*, McGraw-Hill Education, 6th edition, 2017. (*Chapters 1 to 7*)
2. G.D. Rai, *Non-Conventional Energy Sources*, 6th ed., New Delhi: Khanna Publishers, 2017. (*Chapters 3 and 4*)

**Reference Book(s):**

1. Yonus A Cengel and Michael A. Boles, *Thermodynamics: an Engineering Approach*, McGraw-Hill Education, 9th edition, 2019.
2. Mahesh M Rathore, *Thermal Engineering*, McGraw-Hill Education, 2010.
3. Sukhatme, S. P., and Nayak, J. K., *Solar Energy: Principles of Thermal Collection and Storage,* 3rd ed., New Delhi: Tata McGraw-Hill India, 2009.
4. R.K. Rajput, *Non-Conventional Energy Sources and Utilization,* 2nd ed., S Chand and Company Ltd, New Delhi, 2019.

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

1. https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8; *NPTEL Video Lecture on Basic Thermodynamics by Prof. S. K. Som, Professor of Mechanical Engineering, IIT Kharagpur.*
2. https://nptel.ac.in/courses/112106318 *NPTEL Video Lecture on Sustainable Energy Technology by Prof. Sayak Banerjee, Professor of Mechanical and Aerospace Engineering, IIT Hyderabad.*

| **Course Articulation Matrix (CAM):** | | **U24OE701B-SDG: SUSTAINABLE HEAT AND ENERGY 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** | **U24OE701B-SDG.1** | 2 | 2 | 1 | - | - | 1 | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO2** | **U24OE701B-SDG.2** | 2 | 2 | 1 | - | - | 1 | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO3** | **U24OE701B-SDG.3** | 2 | 2 | 1 | - | - | 1 | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO4** | **U24OE701B-SDG.4** | 2 | 2 | 1 | - | - | 1 | - | 1 | 1 | - | 1 | 2 | 2 |
| **U24OE701B-SDG** | | **2** | **2** | **1** | **-** | **-** | **1** | **-** | **1** | **1** | **-** | **1** | **2** | **2** |
| **3 – HIGH, 2 – MEDIUM, 1 - LOW** | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement**<br>*The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| CO1 | *differentiate heat and work, and evaluate energy transfer in closed systems for sustainable energy management.* | SDG 4 | Quality Education | Develops fundamental thermodynamic knowledge and analytical skills essential for engineering education and energy system understanding. |
| CO2 | *assess the performance of thermodynamic devices using SFEE and second-law principles for energy efficiency and sustainability.* | SDG 7 | Affordable and Clean Energy | Promotes efficient energy conversion and performance improvement of thermodynamic systems for sustainable energy utilization. |
| CO3 | *classify sustainable and renewable energy sources, including solar, hydrogen, and other non-conventional technologies.* | SDG 7 | Affordable and Clean Energy | Promotes renewable energy sources such as solar, hydrogen, wind, biomass, geothermal, and tidal energy to provide sustainable and clean energy. |
| CO4 | *analyze sustainable energy conversion technologies such as MHD, thermoelectric, thermionic systems, and biogas generation.* | SDG 7 | Affordable and Clean Energy | MHD, thermoelectric, thermo-ionic, and biogas technologies provide alternative and renewable energy generation methods. |
| | | SDG13 | Climate Action | Clean energy technologies and biogas reduce dependence on fossil fuels and lower greenhouse gas emissions. |

# SENSORS AND ACTUATORS FOR SUSTAINABLE SMART CITIES AND HEALTH CARE

| | | | |
|---|---|---|---|
| **Class:** B.Tech. VII Semester | | **Branch:** All branches | |
| **Course Code:** | **U24OE701C-SDG** | **Credits:** | **03** |
| **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:** select appropriate sensors & actuators for smart system applications

**CO2:** utilize sustainable smart systems for smart cities, utility & industrial monitoring applications

**CO3:** select appropriate sensors & actuators for smart health care system applications

**CO4:** make use of enabling technologies like IoT, Cloud computing, AIML for sustainable smart cities and healthcare solutions

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction:** Sustainable development goals (SDGs), Fundamentals of sensing and actuation, Smart technologies; Smart cities- Concept, Characteristics, Challenges**;** Smart healthcare ecosystem**-** Concept, Characteristics, Challenges

**Sensors and Actuators:** Sensor characteristics, Classification of sensors- Active, Passive**,** Analog, Digital sensors, Smart sensors; Actuator characteristics, Electrical actuators; Actuation systems- Automatic valves**,** Relays, Motor control**,** HVAC control

**Interfacing of Sensors and Actuators** - Data acquisition systems**,** Signal conditioning**,** ADC, DAC, Microcontroller interface

| **UNIT-II** | **9 Hrs** |
|---|---|

**Smart Systems for Sustainable Smart Cities (*Block diagram approach*):** Environmental Monitoring- Air quality monitoring, Water quality monitoring**,** Weather monitoring, Noise monitoring**;** Smart infrastructure- Smart lighting**,** Intelligent traffic management**,** Smart parking, Smart water distribution**,** Smart energy metering, Waste management

**Smart Systems for Utility and Industrial Monitoring (*Block diagram approach*):** Smart grid**,** Smart agriculture, Structural health monitoring

| **UNIT-III** | **9 Hrs** |
|---|---|

**Sensors and Actuators in Healthcare:** Temperature sensors**,** Blood pressure sensors**,** ECG sensors**,** Glucose sensor**,** Respiration sensor, EMG sensors**,** EEG sensors**,** Pulse oximeter, Drug delivery systems**,** Infusion pumps**,** Pacemakers**,** Prosthetic devices, Rehabilitation robots

**Wearable Healthcare Devices:** Fitness trackers**,** Smart watches**,** Continuous health monitoring**,** Fall detection systems

**Telemedicine:** Remote patient monitoring, Role of IoT, Cloud and AI in health care

| **UNIT-IV** | **9 Hrs** |
|---|---|

**IoT and Cloud computing for Sustainable Smart Cities and Healthcare:** IoT architecture**,** Communication Technologies- Wi-Fi**,** BLE, ZigBee**,** LoRaWAN**,** NB-IoT**,** 5G; Wireless sensor networks**,** Cloud computing applications; Green IoT and Energy Harvesting Techniques, Data privacy, Cybersecurity

**AI for Sustainable Smart Cities and Healthcare:** Machine learning for sensor data, Smart data analytics**,** Edge AI, Predictive maintenance**,** Introduction to AI-assisted diagnosis, Predictive healthcare

**Textbook(s):**

1. Priyanka Mishra and Ghanshyam Singh, *Sustainable, Smart Cities Enabling Technologies, Energy Trends and Potential Applications*, Switzerland, Springer Nature, *2023. (chapters 1,2,3,4,6,7)*
2. Jacob Fraden, *Handbook of Modern Sensors: Physics, Designs and Applications*, 5th Edition, Springer, 2016. *(Chapters 1,3,4,6 to 15, 17,18)*

**Reference Book(s):**

1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press, 2015.
2. John G. Webster, *Medical Instrumentation: Application and Design*, 4th Edition, Wiley India, 2010.
3. Raj Kamal, *Internet of Things: Architecture and Design Principles*, McGraw-Hill Education, 2017.
4. Ramon Pallas-Areny and John G. Webster, *Sensors and Signal Conditioning*, 3rd Edition, Wiley, 2012.

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

1. https://onlinecourses.nptel.ac.in/noc26_cs22; *NPTEL Video Lecture on Sensors and Actuators by Prof. Hardik Jeetendra Pandya, Professor of Electronic Systems Engineering, IISc Bangalore*
2. https://nptel.ac.in/courses/106105166; *NPTEL Video Lecture on Introduction to Internet of Things by Prof. Sudip Misra, Professor of CSE, IIT Kharagpur*
3. https://onlinecourses.nptel.ac.in/noc24_ee68; *NPTEL Video Lecture on Embedded Sensing, Actuation and Interfacing Systems, by Prof. Banibrata Mukherjee, Professor of Advanced Technology Development Centre (ATDC), IIT Kharagpur*

| **Course Articulation Matrix (CAM):** | | **U24OE701C-SDG: SENSORS AND ACTUATORS FOR SUSTAINABLE SMART CITIES AND HEALTH CARE** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** |
| **CO1** | **U24OE701C-SDG.1** | 2 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 1 |
| **CO2** | **U24OE701C-SDG.2** | 2 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 1 |
| **CO3** | **U24OE701C-SDG.3** | 2 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 1 |
| **CO4** | **U24OE701C-SDG..4** | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 1 |
| **U24OE701C-SDG L** | | **2** | **1** | **2** | **1** | **1.25** | **3** | **2** | **2** | **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 | select appropriate sensors & actuators for smart system applications | SDG4 | Quality Education | ✓ Can understand the working principles of sensors, actuators used in Smart systems<br>✓ Strengthens core engineering competencies, thereby promoting quality technical education and skill development essential for lifelong learning and professional growth |
| CO2 | utilize sustainable smart systems for smart cities, utility & industrial monitoring applications | SDG11 | Sustainable Cities and Communities | ✓ Make use of sensor and actuator technologies which enables efficient environmental monitoring, intelligent transportation, smart energy management<br>✓ Make use of resource optimization to support the development of sustainable, safe, and |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| **CO** | **CO Statement** *The student should be able to…* | **Relevant SDG** | **SDG Description** | **Mapping Justification** |
| | | | | resilient cities |
| CO3 | select appropriate sensors & actuators for smart health care system applications | SDG3 | Good Health and Well-being | ✓ Can understand the working principles of sensors, actuators used in Health care systems<br>✓ Select appropriate sensors & actuators to develop smart systems for healthcare monitoring devices, diagnostic equipment, and patient safety systems that contribute to improved health and well-being |
| CO4 | make use of enabling technologies like IoT, Cloud computing, AIML for sustainable smart cities and healthcare solutions | SDG9 | Industry, Innovation and Infrastructure | ✓ develop IoT/AIoT based smart systems which promotes technological innovation, smart infrastructure, digital connectivity, and sustainable industrial solutions for smart city and healthcare applications |

# MICROGRIDS AND DISTRIBUTED GENERATION

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE702A** | **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 operation of microgrid in grid connected and islanded modes*

**CO2 :** *select the DG technology for a given application*

**CO3 :** *analyze the modes of the independent and inverter control for microgrid operation*

**CO4 :** *analyze the protection schemes of microgrid in a distribution network*

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to Microgrid:** Definition, microgrid structure, distribution network dispatch layer and centralized control layer, local control layer, operation modes of micro grid, grid connected operation, islanded operation, control modes of micro grid, inverter control modes, classification of micro grids by capacity and by AC/DC type

| **UNIT-II** | **9 Hrs** |
|---|---|

**Distributed Generation (DG):** Definition, need, types of DGs, modelling of solar Photo Voltaic (PV) systems, Wind Energy Conversion Systems (WECS) and small hydro power plants (SHP), distributed generation challenges and opportunities in India

| **UNIT-III** | **9 Hrs** |
|---|---|

**Control and operation of microgrid:** Three-state control of independent microgrid, steady state constant frequency and constant voltage control, dynamic generator tripping and load shedding control, transient fault protection, inverter control, grid connection and separation control, conditions for grid connection, grid connection logic, grid connected operation of microgrid, islanded operation of microgrid

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Protection of the microgrid:** Special fault characteristics of DG, effects of microgrid on relay, protection of a traditional distribution network, protection of a traditional LV distribution network, impacts of microgrid on relay protection of distribution network, impacts of a microgrid on protection of traditional LV distribution lines microgrid operation and protection strategies, protection scheme for distribution network connected with a microgrid, differential relay protection of the distribution network

**Textbook(s):**


1. Li Fusheng, Li Ruisheng and Zhou Fengquan, *Microgrid Technology and Engineering Application*, Cambridge: Elsevier Academic Press, 2015. *(Chapters 2 to 5)*
2. H. Lee Willis, Walter G. Scott, *Distributed Power Generation Planning and Evaluation*, UK: CRC press, 2000. *(Chapters 1, 9)*


**Reference Book(S):**


1. Nikos Hatziargyriou, *Microgrids Architectures and Control*, ISBN:978-1-118-72068-4, Wiley-IEEE Press, 2014.
2. Stephen peake, *Renewable Energy power for sustainable future*, Oxford Press, 4th edition, 2018.
3. N.B.Klinghoffer, N.J.Themelis and M.J.Castaldi, *Waste to energy (WTE): an introduction*, Science direct, pp 3-14, 2013.
4. Ravindra kumar Yadav; R.P. Singh, *Recent Challenges and opportunities of electrical generation and distribution in rural area of India*, IEEE international conference on current trends towards converging technologies (ICCTCT), 2018.


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

1. *https://onlinecourses.nptel.ac.in/noc24_ee37/preview; NPTEL Video Lecture on Smart Grid: Basics to Advanced Technologies by Prof. N. P. Padhy and Prof. Premalata Jena, Department of Electrical Engineering, IIT Roorkee.*
2. *https://onlinecourses.nptel.ac.in/noc20_ee84/preview; NPTEL Video Lecture on DC Microgrid and Control System by Prof. Avik Bhattacharya, Department of Electrical Engineering, IIT Roorkee.*

| Course Articulation Matrix (CAM): | | U24EE702A: MICROGRIDS AND DISTRIBUTED GENERATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE702A.1 | 2 | 3 | 1 | 2 | 2 | 1 | -- | -- | 1 | 1 | 1 | 2 | 2 |
| CO2 | U24EE702A.2 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| CO3 | U24EE702A.3 | 2 | 2 | 2 | 2 | 3 | 1 | -- | 2 | 2 | 1 | 2 | 2 | 3 |
| CO4 | U24EE702A.4 | 2 | 2 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 3 |
| U24EE702A | | 2 | 2.0 | 2.25 | 1.75 | 1.75 | 2.5 | 1.5 | 1.0 | 1.33 | 1.75 | 1.0 | 1.75 | 2.0 |
| 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 operation of microgrid in grid connected and islanded modes | SDG 7 | Affordable and Clean Energy | Grid-connected and islanded operation modes enable reliable electricity access in remote areas, support energy independence, and facilitate integration of renewable energy into existing grids. |
| CO2 | Select the DG technology for a given application | SDG 7 | Affordable and Clean Energy | Selection of appropriate distributed generation (solar PV, wind, small hydro) ensures cost-effective, clean, and reliable energy supply tailored to local resources and application needs. |
| CO2 | Select the DG technology for a given application | SDG 13 | Climate Action | Promoting renewable-based DG over fossil fuels reduces greenhouse gas emissions, directly contributing to climate change mitigation strategies. |
| CO3 | Analyze the modes of independent and inverter control for microgrid operation | SDG 9 | Industry, Innovation and Infrastructure | Inverter control and independent microgrid operation are key enablers of smart grid infrastructure, supporting stable and resilient power systems essential for industrial and technological innovation. |
| CO4 | Analyze protection schemes of microgrid in a distribution network | SDG 9 | Industry, Innovation and Infrastructure | Robust protection schemes (differential relay, fault detection) ensure reliable operation of distribution networks connected with microgrids, reducing downtime and enhancing infrastructure resilience. |
| CO4 | Analyze protection schemes of microgrid in a distribution network | SDG 11 | Sustainable Cities and Communities | Safe and reliable microgrid protection prevents power outages and electrical hazards, contributing to stable electricity supply for urban and rural communities. |

# MODERN POWER ELECTRONICS

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE702B** | **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 steady-state operation of isolated and non-isolated DC-DC converters

**CO2:** design magnetic components and select power devices for a given converter specification

**CO3:** compare performance of multilevel inverter topologies

**CO4:** analyze the performance of Resonant converters.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Isolated and Non-Isolated DC-DC converters:** Flyback, forward, half-bridge and full-bridge converters, non-isolated DC-DC converters (buck, boost, buck-boost) in continuous and discontinuous conduction mode, voltage mode control, introduction to current mode control.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Design of Power Converters Components:** Design of magnetic components - design of transformer, design of inductor and current transformer - Selection of filter capacitors, Selection of ratings for devices, input filter design, Thermal design

| **UNIT-III** | **9 Hrs** |
|---|---|

**Multi-level Inverters and applications:** Need for multi-level inverters, concept of multi-level, topologies for multi-level, diode clamped, flying capacitor and cascaded H-bridge multilevel inverter configurations, features and relative comparison of these configurations, applications of multi-level inverters

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Resonant converters and applications**: Introduction, Basic resonant circuit concepts, Need for soft switching, zero voltage switching (ZVS) and zero current switching (ZCS), Load resonant converters, Resonant switch converters

**Textbook(S):**


1. R.W. Erickson and Dragan Maksimonic, Fundamentals of Power Electronics, Springer, 3rd Edition, 2020. (Unit-I, Unit-II).
2. M. H. Rashid, Power Electronics: Circuits, Devices & Applications, Pearson Education, 4th ed., 2014, Noida. (Unit-III, Unit-IV).


**Reference Book(S):**


1. Abraham I. Pressman, Switching Power Supply Design, Keith Billings &Taylor Morey, McGraw Hill International, 2017, 3rd Edition.
2. Umanand, L, Power Electronics: Essentials and Applications, John Wiley India, 2009, 1st Edition.


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

https://archive.nptel.ac.in/courses/108/108/108108036/; NPTEL Video Lecture on Design and Simulation of DC-DC converters using open-source tools, by Prof. L. Umanand, Department of Electronic Systems Engineering (DESE), IISc Bangalore.

https://archive.nptel.ac.in/courses/117/103/117103148/ ; NPTEL Video Lecture on Design of Power Electronic Converters, by Prof. Shabari Nath, Department of Electronics and Electrical Engineering, IIT Guwahati

https://archive.nptel.ac.in/courses/108/105/108105180/ ; NPTEL Video Lecture on High Power Multilevel Converters- Analysis, design and operational issues by Prof. Anandarup Das, Department of Electrical Engineering, IIT Delhi.

| Course Articulation Matrix (CAM): | | U24EE702B: MODERN POWER ELECTRONICS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE702B.1 | 3 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | 1 | 3 | 2 |
| CO2 | U24EE702B.2 | 3 | 2 | 3 | 2 | 3 | 1 | - | - | 1 | 1 | 1 | 3 | 3 |
| CO3 | U24EE702B.3 | 2 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | 1 | 2 | 2 |
| CO4 | U24EE702B.4 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | - | - | 1 | 2 | 1 |
| U24EE702B | | 2.5 | 2.5 | 2 | 1.75 | 2 | 1 | - | - | 1 | 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** | analyze steady-state operation of isolated and non-isolated DC-DC converters | **SDG 7** | Affordable and Clean Energy | Efficient DC-DC converters are critical for renewable energy systems (solar, fuel cells), battery charging, and DC microgrids. Analyzing their steady-state operation helps improve energy conversion efficiency, reducing energy waste and supporting clean energy access. |
| **CO2** | design magnetic components and select power devices for a given converter specification | **SDG 9** | Industry, Innovation and Infrastructure | Optimal design of transformers, inductors, and power devices enables compact, reliable, and cost-effective power supplies for industrial drives, telecom infrastructure, and EV charging stations — directly supporting resilient infrastructure and technological innovation. |
| **CO3** | analyze the performance of Resonant converters. | **SDG 7** | Affordable and Clean Energy | Multilevel inverters improve power quality and reduce harmonics in medium/high-voltage applications such as solar PV farms, wind turbines, and industrial motor drives. Comparing topologies helps select cost-effective and efficient solutions for clean energy integration. |
| **CO4** | analyze the performance of Resonant converters. | **SDG 9** | Industry, Innovation and Infrastructure | Soft switching (ZVS/ZCS) reduces switching losses, electromagnetic interference (EMI), and thermal stress on components. This leads to more reliable and compact power converters — essential for advanced manufacturing, electric vehicles, and sustainable industrial systems. |

# DISTRIBUTION SYSTEM PLANNING AND AUTOMATON

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE702C** | **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 planning aspects of electric power distribution systems, compare different load forecasting techniques, and evaluate load characteristics, load management strategies, and tariff structures

**CO2 :** analyze the design, operation, efficiency, regulation, and applications of single-phase, three-phase, and special distribution transformers used in distribution systems

**CO3:** analyze substation planning, primary distribution system characteristics, feeder performance, and power factor improvement techniques for efficient operation of distribution systems.

**CO4:** analyze distribution system protection, automation schemes, communication protocols, and grounding methods for reliable and efficient operation of distribution systems.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Power sector in India:** An overview of distribution systems, Distribution system planning issues and aspects, Introduction to Distribution system forecasting techniques, Stochastic and time series techniques for forecasting, intelligent techniques based load forecasting techniques, Definitions and importance of various terms that characterize loads, Load management and types of tariffs

| **UNIT-II** | **9 Hrs** |
|---|---|

**Distribution transformers (DTRs):** Basic design considerations, 3-ph and 1-ph DTRs-types of connections and its relevance in operation, Need for special types of distribution transformers, Cast resin, CSP, Amorphous core DTRs, Regulation and efficiency of transformers-use of predetermined curves

| **UNIT-III** | **9 Hrs** |
|---|---|

**Sub-transmission system:** Sub-stations site selection procedure, Sub-station capacity expansion, Location of new sub-stations and their rating, Sub-station bus schemes, VD and PL calculations for a service area with four and six feeders, VD and PL calculations for a service area with n feeders, Characteristics of primary systems, Voltage drop (VD) and power loss (PL) calculations, Importance of power factor in distribution systems, Capacitors and their role in improving power factor

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Distribution system protection:** Distribution system protection devices, Problems in distribution systems and the need for automation

**Distribution system automation (DSA):** General schematic, DSA-Hardware modules and their functions, DSA-Software modules and their functions, DSA-Alternatives in Communication media, Communication protocols for DSA schemes and need for DSA, Examples of DSA schemes, Distribution system grounding

**Textbook(s):**


1. Turan Gonen, *Electrical power Distribution System Engineering*, CRC Press, 2/e, 2007.
2. A S Pabla, *Electric Power Distribution*, Tata Mc Graw Hill Publisher, 5/e, 2004.


**Reference Book(S):**


1. James A Momoh, *Electric Power Distribution, Automation, Protection and Control,* CRC Press, 1/e, 2007.


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

https:// https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee35; *NPTEL Video Lecture on Operation and Planning of Power Distribution Systems by Prof. Sanjib Ganguly, Professor of EEE, IIT Guwahati.*

| Course Articulation Matrix (CAM): | | U24EE702C : DISTRIBUTION SYSTEM PLANNING AND AUTOMATON | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE702C.1 | 3 | 3 | 1 | 2 | 2 | – | – | – | – | – | 1 | 3 | 2 |
| CO2 | U24EE702C.2 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | 1 | 3 | 2 |
| CO3 | U24EE702C.3 | 3 | 3 | 2 | 3 | 2 | – | 1 | – | – | – | 2 | 2 | 3 |
| CO4 | U24EE702C.4 | 3 | 3 | 2 | 3 | 3 | – | 1 | – | 1 | 1 | 2 | 2 | 3 |
| U24EE702C | | 3 | 3 | 1.75 | 2.5 | 2.25 | - | 1 | - | 1 | 1 | 1.5 | 2.5 | 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 | Analyze the planning aspects of electric power distribution systems, compare different load forecasting techniques, and evaluate load characteristics, load management strategies, and tariff structures | SDG7 | Affordable and Clean Energy | Proper distribution planning, forecasting, and load management help in efficient utilization of electrical energy and support reliable, affordable, and sustainable power delivery. |
| CO2 | Analyze the design, operation, efficiency, regulation, and applications of single-phase, three-phase, and special distribution transformers used in distribution systems | SDG9 | Industry, Innovation and Infrastructure | Efficient transformer operation and modern transformer technologies reduce transmission losses, improve energy efficiency, and strengthen power infrastructure. |
| CO3 | Analyze substation planning, primary distribution system characteristics, feeder performance, and power factor improvement techniques for efficient operation of distribution systems. | SDG11 | Sustainable Cities and Communities | Efficient substation and feeder planning reduce power losses and improve voltage regulation, supporting sustainable and reliable electricity supply for urban and rural communities. |
| CO4 | Analyze distribution system protection, automation schemes, communication protocols, and grounding methods for reliable and efficient operation of distribution systems. | SDG9 | Industry, Innovation and Infrastructure | Distribution automation and protection systems enhance grid reliability, safety, and smart infrastructure development for modern power systems. |

# POWER SYSTEM OPERATION AND CONTROL

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE703** | **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 :** compute the state variables & the power flows in a power system using Gauss-Seidal & Newton-Raphson methods

**CO2 :** determine the optimal economic load scheduling for a given power demand.

**CO3 :** analyze frequency response of a single are and two area system with and without PI controllers

**CO4 :** analyse the stability of power systems and determine the critical clearing angle & critical clearing time.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Load flow studies:** Introduction, Bus classification, Nodal admittance matrix, Load flow equations, Iterative methods – Gauss, Gauss Seidel and Newton Raphson methods, Newton decoupled and fast decoupled, Merits and Demerits of these methods.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Economic Operation of Power Systems**: Distribution of load between units within a plant, transmission loss as a function of plant generation, calculation of loss coefficients, distribution of load between plants. Unit commitment: Introduction, constraints in unit commitment problems.

| **UNIT-III** | **9 Hrs** |
|---|---|

**Load Frequency control**: Introduction, Load frequency problem, Megawatt frequency (or P-F) control channel, MVAr voltage (or Q – V) control channel. Dynamic interaction between P-F and Q-V loops, Mathematical model of speed governing system, turbine models division of power system into control areas, P-F control of single control area ( the uncontrolled and PI controlled cases) P-F control of two area systems (the uncontrolled and PI controlled cases).

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Power System Stability:** The stability problem, steady state stability, transient stability, dynamic stability, steady state stability limit, swing equation, equal area criterion of stability and its applications, critical clearing angle, step by step solution of swing equation, factors affecting transient stability & Methods of improving stability.

**Textbook(s):**


1. D.P. Kothari, I.J. Nagarath, & R Saket, Modern Power System Analysis, Tata McGraw Hill Education (India) Pvt. Ltd, 5th edition, 2022, New Delhi.


**Reference Book(S):**


1. C.L. Wadhwa, Electrical Power Systems, New Age International Pvt. Ltd., 8th edition, 2022, New Delhi.
2. O. I. Elgerd, Electric Energy Systems Theory, Tata McGraw Hill Education (India) Pvt. Ltd.,2nd edition, 2011, New Delhi.
3. J. Grainger & W.D. Stevenson, Power System Analysis, Tata McGraw Hill Education (India) Pvt. Ltd., 2017, New Delhi
4. Chakrabarthi, Abhijit Halder, Power System Analysis: Operation and Control, 4th ed., New Delhi: Prentice hall of India, 2022.


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

1. Unit1: https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee120
2. Unit2:https://www.youtube.com/watch?v=zkN13OmgGOs&list=PLuv3GM6-gsE3hBISUD7NENAVe2e_kXUIC&index=1
3. Unit3: https://nptel.ac.in/courses/108104052
4. Unit4:https://youtube.com/playlist?list=PLbRMhDVUMngeJSl9wldApgLKaxOBZguzN&si=glGNUJYL4151Onqw

| Course Articulation Matrix (CAM): | | U24EE703: POWER SYSTEM OPERATION AND CONTROL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE703.1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | 2 | 1 |
| CO2 | U24EE703.2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | 2 | 1 |
| CO3 | U24EE703.3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | 2 | 1 |
| CO4 | U24EE703.4 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | 2 | 1 |
| U24EE703 | | 2 | 1.75 | 1 | 1 | 1 | 1 | 1 | - | | - | 1 | 2 | 1 |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| CO | CO Statement<br>*The student should be able to…* | Relevant SDG | SDG Description | Mapping Justification |
| CO1 | compute the state variables & the power flows in a power system using Gauss-Seidal & Newton-Raphson methods | **SDG 7** | Affordable and Clean Energy | Accurate power flow computation is essential to maintain grid functionality and integrate renewable energy sources efficiently |
| CO2 | determine the optimal economic load scheduling for a given power demond. | **SDG 12** | Responsible Consumption and Production | Economic dispatch minimizes fuel consumption, reduces generation wastage, and directly cuts carbon emissions from power plants |
| CO3 | describe frequency response of a single are and two area system with and without PI controllers | **SDG 7** | Affordable and Clean Energy | Load frequency control guarantees a continuous, stable, and high-quality electrical power supply to consumers without grid collapses |
| CO4 | analyse the stability of power systems and determine the critical clearing angle & critical clearing time. | **SDG 9** | Industry, Innovation, and Infrastructure | Stability analysis protects transmission networks from catastrophic failure and builds a highly resilient power infrastructure |

# SWITCHGEAR AND PROTECTION

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE 704** | **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 fundamental principles of circuit breakers & fuses and identify suitable relay for a given application*

**CO2 :** *analyze the operation of electromagnetic relays*

**CO3 :** *analyze the operation of static relays & features of numerical relays*

**CO4 :** *apply suitable protection scheme for protection of transmission lines, generators & transformers*

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to switch gear:** Introduction, principle of circuit interruption, short circuit studies in power systems, circuit breakers, types and characteristics, circuit breaker rating, restriking voltage, transient, characteristics of restriking voltage, circuit breaker operating mechanism

**Types of circuit breakers:** Air-break, oil circuit breakers, air-blast circuit breaker, vacuum circuit breakers, $SF_6$ circuit breakers modification of circuit breaker duty by shunt resistors, HVDC circuit breaking, H.R.C. fuses, applications

| **UNIT-II** | **9 Hrs** |
|---|---|

**Introduction to protection relays:** Basic ideas of relay protection, need for protection relaying in power systems,Basic requirements of protective relaying, principles and characteristics of protective relaying

**Classification of relays**: Theory of application of relays, principal types of electromagnetic relays, theory of induction relay torque, over current relays, instantaneous over current relay, directional relays, distance relays, differential relay

| **UNIT-III** | **9 Hrs** |
|---|---|

**Static relays**: Basis for Static relay development, classification of static relays, basic componentsof static relays, over current relay, differential protection and static distance protection

**Numerical relays**: Introduction to numerical relays, features of numerical relays, numerical relay issues

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Protection of transmission lines**: Protection of transmission line with distance relays, effect of arc resistance, effect of power swings, over current and differential relays, unit protection of transmission, bus protection

**Protection of generator and transformer:** Generator protection with differential relays, earth fault relays. transformer protection with differential relays, earth fault relays, Buchholz relay

**Textbook(s):**


1. Badhri Ram, D. N. Vishwakarma, *Power System Protection And Switchgear*, 2nd ed., New Delhi: McGraw Hill (India) Private Limited,2011.
2. B. Ravindranath , M. Chander, *Power System Protection and Switchgear*, 2nd ed., New Delhi: New Age International (P) Ltd., 2011


**Reference Book(S):**


1. Sunil S. Rao, *Switchgear Protection and Power Systems*, 14th ed., New Delhi: Khanna Publishers, 2019.
2. U. A. Bakshi, M. V. Bakshi, *Switchgear and Protection*, Pune: Technical Publications, 2014.
3. Y. G. Paithankar & S. R. Bhinde, *Fundamentals of Power System Protection*, 2nd ed., New Delhi: PHI Learning Pvt. Ltd., 2014.
4. T.S Madhava Rao, *Power Systems Protection: Static Relays*, New Delhi: McGraw Hill (India) Private Limited, 2014.


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

https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Dital Image Processing by Prof. Bhavesh Kumar R.Bhalija , Professor of EEE, IIT Roorkee.*

| Course Articulation Matrix (CAM): | | U24EE 704: SWITCHGEAR AND PROTECTION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE704.1 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 2 | 2 |
| CO2 | U24EE704.2 | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 2 | 2 |
| CO3 | U24EE704.3 | 3 | 2 | 2 | 1 | - | - | - | - | 1 | 1 | - | 2 | 2 |
| CO4 | U24EE704.4 | 3 | 3 | 2 | 2 | - | - | - | - | 1 | 1 | - | 3 | 2 |
| U24EE704 | | 3 | 2.25 | 1.5 | 1.5 | | | | | 1 | 1 | | 2.25 | 2 |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| CO | CO Statement | Relevant SDG | SDG Description | Mapping Justification |
| CO1 | Analyze fundamental principles of circuit breakers & fuses and identify suitable relay | SDG7 | Affordable and Clean Energy | Ensures reliable and efficient power delivery, reduces energy losses, and supports safe operation of electrical systems. |
| CO2 | Analyze the operation of electromagnetic relays | SDG9 | Industry, Innovation and Infrastructure | Enhances industrial safety and reliability through effective protection mechanisms. |
| CO3 | Analyze the operation of static relays & features of numerical relays | SDG9 | Industry, Innovation and Infrastructure | Supports smart grid development and improves fault detection accuracy. |
| CO4 | Apply suitable protection scheme for transmission lines, generators & transformers | SDG11 | Sustainable Cities and Communities | Ensures stable and uninterrupted power supply for sustainable infrastructure. |

# ELECTRIC VEHICLES

| | | | |
|---|---|---|---|
| **Class:** B.Tech. VII -Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE705** | **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 :** compute the state variables & the power flows in a power system using Gauss-Seidal & Newton-Raphson methods

**CO2 :** determine the optimal economic load scheduling for a given power demand.

**CO3 :** analyze frequency response of a single are and two area system with and without PI controllers

**CO4 :** analyse the stability of power systems and determine the critical clearing angle & critical clearing time.

| **UNIT-I** | **9 Hrs.** |
|---|---|

**Introduction to Electric Vehicles (EVs):** Brief History of EVs, Electric vehicles and the environment: Vehicle pollution, Developments towards the end of the 20th century, types of electric and hybrid electric vehicles in use today, electric vehicles for the future

**Batteries:** Introduction, Battery parameters, Types - Lead acid batteries, Nickel-based batteries, Sodium-based batteries, Lithium batteries, Metal air batteries, Use of batteries in electric and hybrid vehicles

| **UNIT-II** | **9 Hrs.** |
|---|---|

**Electric Machines and Controllers for EVs:** Brushed DC electric motor, DC regulation: buck and boost regulators and voltage conversion: single phase and three phase inverters

**Brushless Electric Motors:** Brushless DC motor, switched reluctance motors, induction motor, motor cooling, efficiency, size and mass, electrical machines for hybrid vehicles

| **UNIT-III** | **9 Hrs** |
|---|---|

**Electric Vehicle Modelling:** Tractive effort-rolling resistance force, aerodynamic drag, hill climbing force, acceleration force, total tractive effort; Modelling vehicle acceleration: acceleration performance parameters, modelling the acceleration of an electric scooter, modelling the acceleration of a small car, modelling electric vehicle range: driving cycles, range modelling of battery electric vehicles, constant velocity range modelling

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Battery Charging:** Battery chargers, charge equalization, designer's choice of battery

**Battery Modelling**: The purpose of battery modelling, battery equivalent circuit, modelling battery capacity, simulation of a battery at a set power, calculating the Peukert coefficient, approximate battery sizing

**Textbook(s):**


1. James Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons Ltd., 1st ed., 2003.


**Reference Books:**


1. C. Mi, M. A. Masrur and D. W. Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons, 2nd ed., November 2017.
2. S. Onori, L. Serrao and G. Rizzoni, Hybrid Electric Vehicles: Energy Management Strategies, Springer, 1st ed., 2016.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 1st ed., 2005.
4. T. Denton, Electric and Hybrid Vehicles, Taylor & Francis Group, 1st ed., 2016.


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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ee30, NPTEL course on "EV - Vehicle Dynamics and Electric Motor Drives", by Prof. Amit Jain, Prof. Avanish Tripathi, IIT Delhi.

| Course Articulation Matrix (CAM) | | U24EE705 ELECTRIC VEHICLES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE705.1 | 2 | 1 | - | - | - | 1 | 1 | - | - | - | 1 | 1 | 1 |
| CO2 | U24EE705.2 | 2 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 2 | 1 |
| CO3 | U24EE705.3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | 2 | 2 |
| CO4 | U24EE705.4 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | 2 | 2 |
| U24EE705 | | 2 | 1.5 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1.75 | 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 | Classify electric vehicles and describe various batteries | SDG7 | Affordable and Clean Energy | Understanding electric vehicles and battery technologies promotes clean energy utilization and supports sustainable transportation systems with reduced dependence on fossil fuels. |
| CO2 | Identify motors and controllers used in electric vehicles | SDG9 | Industry, Innovation and Infrastructure | Knowledge of EV motors, controllers, and drive systems contributes to innovative transportation technologies and development of modern sustainable infrastructure. |
| CO3 | Model electric scooter, small electric car and battery electric vehicle | SDG11 | Sustainable Cities and Communities | Electric vehicle modelling supports development of eco-friendly mobility systems, helping create sustainable and smart urban transportation solutions. |
| CO4 | Take part in design and simulation of the batteries used in electric vehicles | SDG13 | Climate Action | Battery design and simulation for EVs contribute to reduction of greenhouse gas emissions and support climate-friendly transportation technologies. |

# POWER SYSTEMS LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE706** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 :** *determine the performance characteristics of a long transmission line & breakdown strength of transformer oil*

**CO2 :** *determine the operating characteristics of protective relays & sequence impedances of transformer*

**CO3 :** *determine the sequence components of alternator and the fault currents*

**CO4 :** *determine the characteristics of PV arrays & reactive power distribution among parallel connected tap changing transformers*

1. Determination of efficiency and voltage regulation of an artificial transmission line
2. Improvement of voltage profile of an artificial transmission line with reactive power injection
3. Determination of breakdown strength of transformer oil
4. Determination of operating characteristics of IDMT over current relay
5. Determination of operating characteristics of static differential relay
6. Determination of sequence impedances of three phase transformer
7. Determination of sequence reactance of an alternator
8. Determination of fault current and voltages of an unloaded alternator subjected to LG fault
9. Determination of fault current and voltages of an unloaded alternator subjected to LL fault
10. Determination of output voltage, current & power and plotting of I-V and P-V curves of series and parallel combinations of PV modules for different temperature and radiation levels
11. Determination of output voltage, current & power of PV module for different tilt angles and shading conditions and plotting of tilt power output characteristics
12. Determination of distribution of reactive power between two parallel transformers by adjusting voltage magnitude ratios

**Additional experiments:**

13. Determination of voltage profile of IEEE 33-bus radial distribution system
14. Determination of load flows of Neyveli Thermal Power Station (NTPS)-23 bus test system

**Textbook(s):**

1. *Power Systems Laboratory Manual*, Department of EEE, KITSW

**Reference Book(S):**


1. C.L. Wadhwa, *Electrical Power Systems*, 7th ed.,: New Age International Pvt. Ltd., 2016, New Delhi
2. I.J. Nagrath & D.P. Kothari, Modern power system Analysis, 4th ed., New Delhi: Tata McGraw Hill Education Pvt. Ltd., 2012, India.


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

*Power Systems Laboratory Manual*, Department of EEE, KITSW

| Course Articulation Matrix (CAM): | | U24EE706: POWER SYSTEMS LABORATORY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE706.1 | 2 | 2 | - | 2 | - | - | 1 | 2 | 2 | - | 1 | 2 | 2 |
| CO2 | U24EE706.2 | 2 | 2 | - | 2 | - | - | 1 | 2 | 2 | - | 1 | 2 | 2 |
| CO3 | U24EE706.3 | 2 | 2 | - | 2 | - | - | 1 | 2 | 2 | - | 1 | 2 | 2 |
| CO4 | U24EE706.4 | 2 | 2 | - | 2 | - | - | 1 | 2 | 2 | - | 1 | 2 | 2 |
| U24EE706 | | 2 | 2 | - | 2 | - | - | 1 | 2 | 2 | - | 1 | 2 | 2 |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| CO | CO Statement<br>*The student should be able to* | Relevant SDG | SDG Description | Mapping Justification |
| CO1 | determine the performance characteristics of a long transmission line & breakdown strength of transformer oil | SDG 7 | (Affordable and Clean Energy) | Efficient transmission lines reduce energy losses; transformer oil breakdown testing ensures reliability of power transformers, directly supporting reliable energy infrastructure. |
| CO2 | determine the operating characteristics of protective relays & sequence impedances of transformer | SDG 9 | (Industry, Innovation, and Infrastructure) | Protective relays and transformer sequence impedances are critical for grid protection and stable operation, contributing to resilient electrical infrastructure. |
| CO3 | determine the sequence components of alternator and the fault currents | SDG 9 | (Industry, Innovation, and Infrastructure) | Fault current analysis helps design robust protection schemes, preventing blackouts and equipment damage, thus enhancing infrastructure resilience. |
| CO4 | determine the characteristics of PV arrays & reactive power distribution among parallel connected tap changing transformers | SDG 7, SDG 13 | (Affordable and Clean Energy) + (Climate Action) | PV array experiments promote renewable energy adoption (SDG 7); reactive power control improves grid efficiency, reducing losses and emissions (SDG 13). |

# ELECTRICAL SIMULATION LABORATORY

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE707** | **Credits:** | **1** |
| **Hours/Week (L-T-P- E):** | **0-0-2-2** | **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 power electronics converters & renewable energy systems using PSIM

**CO2 :** evaluate performance of transmission lines, load frequency control and determine sequence components using MATLAB

**CO3 :** analyze the models for load flow analysis, short circuit analysis & relay coordination using MI-power

**CO4 :** evaluate the performance of FC-TCR, AC voltage controller using PSCAD & ATC calculations using PWS

## LIST OF EXPERIMENTS

1. Simulation of three phase converter circuits using PSIM.
2. Simulation of solar energy system using PSIM.
3. Simulation of wind energy system using PSIM.
4. Performance evaluation of medium and long transmission lines using MATLAB
5. Symmetrical component analysis using MATLAB
6. Load frequency control of single area power system with and without controller using MATLAB Simulink
7. Load flow analysis using MI Power
8. Short circuit analysis using MI Power.
9. Relay coordination using MI Power.
10. Performance of FC-TCR compensator using PSCAD.
11. Performance of AC voltage controller circuit using PSCAD
12. Available Transfer capability calculations using POWERWORLD SIMULATOR

**Textbook(s):**

1. C.L. Wadhwa, *Electrical Power Systems*, 8th edition, New Age International Pvt. Ltd., 2022, New Delhi.

**Reference Book(S):**

1. D.P. Kothari, I.J. Nagarath, & R Saket, Modern Power System Analysis, Tata McGraw Hill Education (India) Pvt. Ltd, 5th edition, 2022, New Delhi

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

1. https://matlabacademy.mathworks.com/details/matlab-onramp/gettingstarted
2. https://www.udemy.com/course/learn-matlab-from-zero-to-hero/

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

*Electrical simulation Laboratory Manual,* Department of EEE, KITSW

| Course Articulation Matrix (CAM): | | U24EE707 : ELECTRICAL SIMULATION LABORATORY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE707.1 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | - | 2 | 2 | 2 |
| CO2 | U24EE707.2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | - | 2 | 2 | 2 |
| CO3 | U24EE707.3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | - | 2 | 2 | 2 |
| CO4 | U24EE707.4 | 2 | 2 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | - | 2 | 2 | 2 |
| U24EE707 | | 1.75 | 2 | 2.25 | 1.75 | 2.25 | 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 | Simulate and analyze power electronics converters & renewable energy systems using PSIM | SDG7,13 | Affordable and Clean Energy, Climate Action | Simulation of solar and wind energy systems facilitates the design and optimal integration of clean, renewable energy alternatives, which reduces dependency on fossil fuels and combats climate change. |
| CO2 | Evaluate performance of transmission lines, load frequency control, and determine sequence components using MATLAB | SDG 9 | Industry, Innovation, and Infrastructure | Evaluating transmission lines and load frequency control (p. 1) ensures grid stability, efficiency, and reliability, which directly contributes to building resilient and modernized electrical infrastructure. |
| CO3 | Simulate and analyze models for load flow analysis, short circuit analysis & relay coordination using MI-power | SDG 9 | Industry, Innovation, and Infrastructure | Conducting fault analysis and relay coordination prevents power grid failures and ensures a secure, uninterrupted power supply, safeguarding critical urban infrastructure and cities. |
| CO4 | Evaluate the performance of FC-TCR, AC voltage controller using PSCAD & ATC calculations using PWS | SDG7,9 | Affordable and Clean Energy, Industry, Innovation, and Infrastructure | Using compensators and calculating Available Transfer Capability (ATC) maximizes power grid efficiency, minimizes transmission power losses, and supports smart grid innovation. |

## VIII SEMESTER

| S.No. | Category | Course Code | Course Title | Lectures / week | | | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | E | C |
| 1 | PEC | U24EE801 | Program Elective - III / MOOCs-III | 2 | 1 | - | 3 | 3 |
| 2 | PEC | U24EE802 | Program Elective - IV / MOOCs-IV | 2 | 1 | - | 3 | 3 |
| 3 | PCC | U24EE803 | Smart Electric Grid | 2 | 1 | - | 3 | 3 |
| 4 | ELC | U24EE804 | 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 |

**@ 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).

# FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII – Semester | | **Branch:** EEE | |
| **Course Code:** | U24EE801A | **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 Flexible AC Transmission Systems (FACTS), need for power flow control, classifications of FACTS controllers, and the role of power electronic converters in transmission systems.*

**CO2 :** *analyze the operation and performance of shunt compensation techniques including SVC and STATCOM for reactive power control and voltage regulation*

**CO3 :** *analyze the operation and characteristics of series compensation techniques such as TCSC, TSSC, and SSSC for power flow control and transmission enhancement.*

**CO4 :** *evaluate the operation and applications of combined FACTS controllers such as UPFC and IPFC for improving voltage stability, transmission capability, and overall power system performance.*

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to FACTS:** Basics of AC transmission systems, Need for power flow control, Limitations of conventional transmission systems, Concept and definition of FACTS, Benefits of FACTS controllers, Classification of FACTS controllers – Series, Shunt and Combined controllers.

**Power Electronics in FACTS:** Overview of power electronic devices used in FACTS, Introduction to Voltage Source Converters (VSC) and Current Source Converters (CSC), Basic configurations.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Shunt Compensation**: Objectives of shunt compensation, Methods of reactive power control, Thyristor Controlled Reactor (TCR), Thyristor Switched Capacitor (TSC), FC-TCR configuration.

**STATCOM**: Basic configuration, Operating principle, Control approaches, V-I characteristics, Comparison of SVC and STATCOM, Applications of shunt compensation.

| **UNIT-III** | **9 Hrs** |
|---|---|

**Series Compensation:** Objectives of series compensation, Fixed Series Capacitor (FSC), Thyristor Controlled Series Capacitor (TCSC) – Operating principle and characteristics, Thyristor Switched Series Capacitor (TSSC).

**SSSC**: Static Synchronous Series Compensator – Basic configuration, Operating principle, Power flow control, Comparison of series controllers.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Combined FACTS Controllers:** Unified Power Flow Controller (UPFC) – Configuration and operating principles, Interline Power Flow Controller (IPFC) – Basic concept.

**Applications of FACTS:** Voltage control, Power flow control, Stability improvement, Enhancement of transmission capability, Basic case studies and future scope of FACTS.

**Textbook(s):**

1. Narain G. Hingorani, Laszlo Gyugyi -*understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems* – IEEE Press.

**Reference Book(S):**

1. K.R. Padiyar -*FACTS Controllers in Power Transmission and Distribution*, New Age International.
2. Yong Hua Song, Allan T. Johns *Flexible AC Transmission Systems (FACTS)* –, IET.

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

https:// nptel.ac.in/courses/108107114 *by Prof. Avik , Bhattacharya , Professor of EEE, IIT Roorkee.*

| Course Articulation Matrix (CAM): | | U24EE801A: FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE801.1 | 3 | 2 | - | | 1 | - | - | - | - | - | - | 3 | 2 |
| CO2 | U24EE801.2 | 3 | 2 | 2 | 2 | 1 | - | 1 | - | - | - | - | 3 | 2 |
| CO3 | U24EE801.3 | 3 | 2 | 2 | 2 | 1 | - | 1 | - | - | - | - | 3 | 2 |
| CO4 | U24EE801.4 | 3 | 2 | 2 | 2 | 1 | - | 1 | - | - | - | - | 3 | 2 |
| U24EE801 | | 3 | 2 | 2 | 2 | 1 | - | 1 | - | - | - | - | 3 | 2 |
| 3 – HIGH, 2 – MEDIUM, 1 - LOW | | | | | | | | | | | | | | |

| CO–SDG Alignment Matrix | | | | |
|---|---|---|---|---|
| CO | CO Statement | Relevant SDG | SDG Description | Mapping Justification |
| CO1 | explain the fundamentals of Flexible AC Transmission Systems (FACTS), need for power flow control, classifications of FACTS controllers, and the role of power electronic converters in transmission systems. | SDG7 | Affordable and Clean Energy \| | Supports efficient transmission and utilization of electrical energy with reduced transmission losses. |
| CO2 | analyze the operation and performance of shunt compensation techniques including SVC and STATCOM for reactive power control and voltage regulation | SDG9 | Industry, Innovation and Infrastructure | Enhances modern power infrastructure reliability and voltage stability using advanced compensation technologies |
| CO3 | analyze the operation and characteristics of series compensation techniques such as TCSC, TSSC, and SSSC for power flow control and transmission enhancement. | SDG7 | Affordable and Clean Energy \| | Improves transmission efficiency and power transfer capability in electrical networks. |
| CO4 | evaluate the operation and applications of combined FACTS controllers such as UPFC and IPFC for improving voltage stability, transmission capability, and overall power system performance. | SDG11 | Sustainable Cities and Communities \| | Ensures stable, reliable, and sustainable power delivery for modern smart grid applications and urban infrastructure. |

# HVDC TRANSMISSION

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE801B** | **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,*
*(based on cognitive skills acquired from theory component)*

**CO1:** compare EHV AC and HVDC system and to describe various types of DC links and analyze Graetz circuit for rectifier and inverter mode of operation

**CO2:** analyze methods for the control of HVDC systems and reactive power control

**CO3:** perform power flow analysis in AC/DC systems and protection methods for HVDC systems

**CO4:** describe various and classify harmonics and design different types of filters

| **UNIT-I** | **9 Hrs** |
|---|---|

**DC Power Transmission**: Need for power system interconnections, comparison of HVDC and HVAC transmission systems, types of DC links and components

**Analysis of HVDC converters**: Choice of converter configuration, analysis of Graetz circuit with and without overlap, Characteristics of 6-pulse and 12-pulse converters, voltage waveforms, analysis of two and three valve conduction mode, converter bridge characteristics, inverter mode of operation, cases of two 3 phase converters in Y/Y mode and their performance

| **UNIT-II** | **9 Hrs** |
|---|---|

**Converter and HVDC System Control:** Principle of DC link control, converters control characteristics, firing angle control, current and extinction angle control, effect of source inductance on the system, Starting and stopping of DC link, power control

**Reactive Power Control in HVDC:** Introduction, Reactive Power Requirements in steady state, sources of reactive power- Static VAR Compensators, Reactive power control during transients

| **UNIT-III** | **9 Hrs** |
|---|---|

**Power Flow Analysis in AC/DC Systems:** Modelling of DC links, DC network, DC converter, controller equations, solution of DC load flow, P.U.System for DC quantities, solution of AC-DC power flow-simultaneous method-sequential method

**Converter Faults and Protection:** Converter faults, protection against over current and over voltage in converter station, surge arresters, smoothing reactors, DC breakers, audible noise, space charge field, corona effects on DC lines

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Harmonics:** Generation of harmonics, characteristics harmonics, calculation of AC harmonics, Non-Characteristics harmonics, adverse effects of harmonics, calculation of voltage and current harmonics, effect of pulse number on harmonics

**Filters:** Types of AC filters, design of single tuned filters –design of high pass filters.

**Textbook(S):**


1. K.R.Padiyar, "HVDC Power Transmission Systems-Technology and system Interactions", New Age International (P) Limited.,Publishers, First edition: 1990, reprint 2005,New Delhi.
2. S K Kamakshaiah, V Kamaraju, " HVDC Transmission" TMH Publishers, 2nd ed.,2020


**Reference Book(S):**


1. S.Rao,"EHVAC and HVDC Transmission Engineering and Practice",Khanna publications, 3rd Edition 1999.
2. Jos Arrillaga, "HVDC Transmission, The institution of electrical engineers", IEE power &energy series 29, 2nd edition 1998.
3. E. W. Kimbark,"Direct Current Transmission",John Wiley and Sons,volume 1, 1971,New york


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

1. https://nptel.ac.in/courses/108104013; *NPTEL Video Course on High Voltage DC transmission by Prof.S.N.Singh, Professor at Department of Electrical Engineering, IIT Kanpur*
2. https://nptel.ac.in/courses/108106160; *NPTEL Video Course on DC Power Transmission Systems by Prof. Krishna S, Professor at Department of Electrical Engineering IIT Madras*

| Course Articulation Matrix (CAM): | | U24EE801B: HVDC Transmission | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE801B.1 | 3 | 2 | 1 | 1 | 1 | 1 | - | 1 | 1 | - | 1 | 2 | 1 |
| CO2 | U24EE801B.2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 |
| CO3 | U24EE801B.3 | 2 | 2 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| CO4 | U24EE801B.4 | 2 | 2 | 1 | 1 | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - |
| **U24EE801B** | | **2.5** | **2** | **1** | **1** | **0.5** | **1** | **0.75** | **1** | **1** | **0.5** | **1** | **1.5** | **0.5** |
| **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** | compare EHV AC and HVDC system and to describe various types of DC links and analyze Graetz circuit for rectifier and inverter mode of operation | SDG 7 | Affordable and Clean Energy | Understanding EHV AC vs HVDC systems and DC links helps in designing efficient long-distance power transmission, reducing losses and enabling integration of renewable energy sources. |
| **CO2** | Describe various methods for the control of HVDC systems and reactive power control | SDG 7 | Affordable and Clean Energy | Control of HVDC systems and reactive power improves energy efficiency, voltage stability, and optimal utilization of power systems, directly supporting clean and reliable energy delivery. |
| **CO3** | perform power flow analysis in AC/DC systems and protection methods for HVDC systems | SDG 9 | Industry, Innovation and Infrastructure | Power flow analysis and protection methods contribute to robust, reliable, and modern power infrastructure, which is essential for industrial growth and innovation. |
| **CO4** | describe various and classify harmonics and design different types of filters | SDG 7 | Affordable and Clean Energy | Harmonics analysis and filter design improve power quality, reduce losses, and ensure efficient and sustainable operation of electrical systems, supporting both clean energy and advanced infrastructure |

# DIGITAL CONTROL SYSTEMS

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE801C** | **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 :** differentiate between continuous-time and discrete-time control methods and Solve any function usingz-transforms and inverse z-transforms

**CO2 :** analyze discrete-time control systems in Z-plane and realize digital controllers using pulse transfer function concepts.

**CO3 :** apply state variable techniques for analysis of digital control systems including controllability and observability.

**CO4 :** design and analyze digital control systems using stability analysis, root locus and frequency response techniques in Z-plane.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to Discrete Control Systems:** Introduction, Discrete time control, Continuous timecontrol, Comparison, Block diagram of digital control.

**Z-Transforms**: Z-Transforms of elementary functions, Properties, Inverse Z-transforms, Z-transform method for solving difference equations.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Discrete type control system in Z-plane Analysis:** Introduction, Impulse sampling and data hold, Z-transform by convolution Integral method. Reconstruction of original signal from sampled signal pulse transfer function and, Realization of Digital Controllers.

| **UNIT-III** | **9 Hrs** |
|---|---|

**State Variable Analysis of Digital Control Systems**: Introduction, State description of digital processors, State description of sampled continuous time plants, state description of systems with dead time, solution of state difference equation, controllability and observability, Multi variable systems.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Design of Digital Control:** Introduction, Mapping between S-plane and Z-plane, Stability analysis of closed loop system in Z-plane, Transient and Steady State response analysis, Design based on Root locus method, frequency response method and analytical design method.

**Textbook(s):**


1. K. Ogata, *Discrete time control systems*, Pearson Education India, 2nd edition, 2016.


**Reference Book(S):**


1. M. Gopal, *Digital Control and State Variable Methods*, McGraw Hill Education, 4th edition, 2017.
2. C.L. Phillips, H.T. Nagle, A. Chakrabortty, *Digital Control System Analysis and Design*, Pearson, 4th edition,2014.
3. B.C. Kuo, *Digital Control Systems*, Oxford University Press, 2nd edition, 2012.
4. C.A. Rabbath, N. Lechevin, *Discrete-Time Control System Design with Applications*, Springer Verlag New York Inc, 2nd edition,2003.


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

1. https://nptel.ac.in/courses/108105186
2. https://nptel.ac.in/courses/108103008

| Course Articulation Matrix (CAM): | | U24EE801C : DIGITAL CONTROL SYSTEMS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE801C.1 | 3 | 3 | 1 | 1 | 2 | – | – | – | – | – | 1 | 3 | 2 |
| CO2 | U24EE801C.2 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | 1 | 3 | 3 |
| CO3 | U24EE801C.3 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | – | 1 | 2 | 3 |
| CO4 | U24EE801C.4 | 3 | 3 | 3 | 2 | 2 | – | – | – | - | - | 1 | 3 | 3 |
| U24EE801C | | 3 | 3 | 2 | 1.75 | 2 | - | - | - | - | - | 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 | differentiate between continuous-time and discrete-time control methods and Solve any function using z-transforms and inverse z-transforms | SDG4 | Quality Education | Enhances knowledge and analytical skills in digital control systems and transform techniques. |
| CO2 | analyze discrete-time control systems in Z-plane and realize digital controllers using pulse transfer function concepts. | SDG9 | Industry, Innovation and Infrastructure | Strengthens advanced learning in sampled-data and digital control systems. |
| CO3 | apply state variable techniques for analysis of digital control systems including controllability and observability. | SDG9 | Industry, Innovation and Infrastructure | Enables innovation in multi-variable and advanced digital control systems |
| CO4 | Design and analyze digital control systems using stability analysis, root locus and frequency response techniques in Z-plane. | SDG7 | Affordable and Clean Energy | Supports reliable and energy-efficient operation of automated systems |

# POWER SYSTEM DEREGULATION

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE802A** | **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,*
*(based on cognitive skills acquired from theory component)*

**CO1 :** *compare the performance of pool, bilateral & hybrid models of restructured power markets and propose suitable models for restructuring of electric markets*

**CO2 :** *analyze the activities of ISO & GENCO in deregulated electricity markets and compute ATC*

**CO3 :** *identify the challenges involved in electricity pricing and predict the electricity forward curves based on given electricity market conditions*

**CO4 :** *analyze the impact of Electricity Act 2003 on Indian electricity sector*

| **UNIT-I** | **9 Hrs** |
|---|---|

**Overview of Key Issues in Electric Utilities:** Introduction, restructuring models, Independent System Operator (ISO), power exchange, market operations, market power

| **UNIT-II** | **9 Hrs** |
|---|---|

**Power System Operation in a Competitive Environment:** Introduction, operational planning activities of ISO in pool markets and bilateral markets, operational planning activities of generation units (GENCO) in pool and bilateral markets

**Available Transfer Capability (ATC):** Definition, issues, calculation of ATC

| **UNIT-III** | **9 Hrs** |
|---|---|

**Electricity Pricing:** Introduction, electricity price volatility electricity price indexes, challenges to electricity pricing, forward price curves, short-time price forecasting

**Transmission Open Access and Pricing:** Power wheeling, types of transmission services in open access, cost components in transmission.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Indian Power Sector:** Evolution of Indian power sector, Salient features of Electricity Act 2003, Structure of Indian Electricity sector, functions of electricity regulators in India, role of RLDC, SLDC, RPC, CTU, CEA, STU, transmission open access, Indian Power Exchange (IEX)

**Textbook(s):**


1. Mohammad Shahidehpour, and Muwaffaq Alomoush, *Restructured Electrical Power systems*, CRC Press, 2001, United States. *(Chapters 1, 7)*
2. Kankar Bhattacharya, Math H.J. Boller, Jaap E.Daalder, *Operation of Restructured Power System*, Kluwer Academic Publisher, 2001, United States. *(Chapters 3, 4)*
3. Pratik Biswas, Sukanya Mandal, *Indian Electricity Sector under regulatory regime*, White Falcon Publishing, 2019, Kolkata. *(Chapters 2, 4 to 5)*


**Reference Book(S):**


1. P. Venkatesh, B. V. Manikandan, S. Charles Raja, A. Srinivasan, *Electrical Power Systems: Analysis, Security and Deregulation*, PHI Learning Pvt. Ltd., 2012, New Delhi.
2. Loi Lei Lai (Ed), *Power System Restructuring and Deregulation: Trading, performance and Information Technology*, John Wiley publications, 2001, United States.

3. Fred I Denny and David E. Dismukes, *Power System Operations and Electricity Markets*, CRC Press, 2002, United States.

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

ps://www.youtube.com/@powersystemz/featured; *Video Lecture on Restructured power system by Prof. N. P. Padhy and Prof. Premalata Jena, Department of Electrical Engineering, IIT Roorkee.*

| Course Articulation Matrix (CAM): | | U24EE802A: POWER SYSTEM DEREGULATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE802A.1 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO2 | U24EE802A.2 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO3 | U24EE802A.3 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 1 |
| CO4 | U24EE802A.4 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 | 2 | 1 |
| **U24EE802A** | | **2** | **1** | **1** | **1** | **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 | compare the performance of pool, bilateral & hybrid models of restructured power markets and propose suitable models for restructuring of electric markets | SDG 7 | Affordable and Clean Energy | Restructured power markets improve efficiency, competition, and reliability in electricity supply, directly supporting SDG 7. |
| CO2 | analyze the activities of ISO & GENCO in deregulated electricity markets and compute ATC | SDG 9 | Industry, Innovation, and Infrastructure | ISO/GENCO functions and ATC calculation relate to efficient grid operation, essential for modern energy infrastructure (SDG 9). |
| CO3 | identify the challenges involved in electricity pricing and predict the electricity forward curves based on given electricity market conditions | SDG 12 | Responsible Consumption and Production | Electricity pricing affects consumption behavior; forward curves support efficient market decisions, promoting responsible energy use (SDG 12). |
| CO4 | analyze the impact of EA 2003 on Indian electricity sector | SDG 7 | Affordable and Clean Energy | Electricity Act 2003 restructured Indian power sector, introduced open access, and promoted competition, directly contributing to SDG 7 targets. |

# MODELING AND SIMULATION OF ELECTRICAL MACHINES

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE802B** | **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 electromagnetic energy conversion principles to analyze magnetic circuits, torque production, machine windings, inductances, and voltage equations.

**CO2:** analyze force and torque production in singly and doubly excited systems using electromagnetic energy conversion principles.

**CO3:** analyze the steady-state and dynamic performance of three-phase induction machines using equivalent circuits, reference frame theory, and digital simulation techniques.

**CO4:** analyze the steady-state and dynamic performance of three-phase synchronous machines using Park's equations and generalized machine theory.

| **UNIT-I** | **9 Hrs** |
|---|---|

**PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION:** Magnetic circuits, permanent magnet, stored magnetic energy, co-energy- force and torque in singly and doubly excited systems- machine windings and air gap mmf - winding inductances and voltage equations.

| **UNIT-II** | **9 Hrs** |
|---|---|

**DC MACHINES MODELLNG:** Elementary DC machine and analysis of steady state operation - voltage and torque equations - solution of dynamic characteristics by Laplace transform - digital computer simulation of permanent magnet and shunt D.C machines. **REFERENCE FRAME THEORY**: types of transformation, transformation of variables from stationary to arbitrary reference frame

| **UNIT-III** | **9 Hrs** |
|---|---|

**INDUCTION MACHINES MODELLING**: Three phase induction machine, equivalent circuit and analysis of steady state operation - free acceleration characteristics - voltage and torque equations in machine variables and arbitrary reference frame variables - analysis of dynamic performance for load torque variations - digital computer simulation.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**SYNCHRONOUS MACHINES MODELLING**: Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) - analysis of dynamic performance for load torque variations -Generalized theory of rotating electrical machine and Kron's primitive machine

Textbook(S):


1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, 2010 , Second Edition
2. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008


Reference Book(S):


1. A.E, Fitzgerald, Charles Kingsley, Jr and Stephan D, Umanx, "Electric Machinery",Tata McGraw Hill, 1992, 5th Edition.
2. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, New Delhi, Prentice Hall of India, 2001.


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

1. https://nptel.ac.in/courses/108106023 NPTEL Video Lecture on Modelling and Analysis of Electric Machines by Dr. Krishna Vasudevan, Department of Electrical Engineering,IIT Madras

| Course Articulation Matrix (CAM): | | U24EE802B: MODELING AND SIMULATION OF ELECTRICAL MACHINE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE802B.1 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | - | 1 | 2 | 3 |
| CO2 | U24EE802B.2 | 3 | 3 | 1 | 1 | 2 | - | - | - | - | - | 1 | 2 | 3 |
| CO3 | U24EE802B.3 | 3 | 3 | 2 | 3 | 3 | 1 | - | - | - | - | 2 | 3 | 3 |
| CO4 | U24EE802B.4 | 3 | 3 | 2 | 3 | 3 | 1 | - | - | - | - | 2 | 3 | 3 |
| U24EE802B | | 3 | 2.75 | 1.5 | 2 | 2.5 | 1 | - | - | - | - | 1.5 | 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** | Apply electromagnetic energy conversion principles to analyze magnetic circuits, torque production, machine windings, inductances, and voltage equations. | **SDG 7** | Affordable and Clean Energy. | Understanding electromagnetic energy conversion and machine parameters helps in designing efficient electrical machines with reduced losses and improved energy utilization, supporting sustainable and clean energy systems. |
| **CO2** | Analyze force and torque production in singly and doubly excited systems using electromagnetic energy conversion principles. | **SDG 9** | Industry, Innovation and Infrastructure | Analysis of force and torque production contributes to the development of advanced electrical machines and innovative industrial technologies with improved performance and reliability. |
| **CO3** | Analyze the steady-state and dynamic performance of three-phase induction machines using equivalent circuits, reference frame theory, and digital simulation techniques. | **SDG 7** | Affordable and Clean Energy | Modelling and simulation of induction machines enable efficient machine control, reduced energy losses, and optimal utilization of electrical energy in industrial and power system applications. |
| **CO4** | Analyze the steady-state and dynamic performance of three-phase synchronous machines using Park's equations and generalized machine theory. | **SDG 9** | Industry, Innovation and Infrastructure | Advanced analysis and control of synchronous machines support innovation in industrial automation, smart drives, and modern electrical infrastructure development. |

# INDUSTRIAL AUTOMATION AND CONTROL

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII – Semester | | **Branch:** EEE | |
| **Course Code:** | **U24EE802C** | **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 :** classify the components of industrial automation systems and analyze the characteristics of sensors, transducers, and measurement systems

**CO2 :** develop PLC-based solutions for sequence and logic control using appropriate programming techniques.

**CO3 :** analyze process control strategies and evaluate the role of Distributed Control Systems (DCS) in industrial process monitoring and control.

**CO4 :** analyze the architecture, components, and operational functions of SCADA systems for industrial monitoring and supervisory control.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to Industrial Automation and Control:** Introduction to industrial automation and control; evolution and levels of automation; architecture and components of industrial automation systems; industrial sensors and transducers; static characteristics of measurement systems; signal conditioning and data acquisition concepts; measurement errors and calibration.

| **UNIT-II** | **9 Hrs** |
|---|---|

**Programmable Logic Controllers**: Introduction to sequence and logic control systems; limitations of relay-based control and need for PLCs; fundamentals and architecture of Programmable Logic Controllers (PLCs); PLC hardware components, input/output modules, power supply, and CPU; PLC operating cycle and software development environment; basics of PLC programming, ladder logic diagrams, logic functions, timers, counters, and internal relays; introduction to Sequential Function Charts (SFCs);

| **UNIT-III** | **9 Hrs** |
|---|---|

**Process Control:** P-I-D Control, Controller Tuning, Special Control Structures, Feed-forward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control.

**Distributed Control System:** Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

| **UNIT-IV** | **9 Hrs** |
|---|---|

**Supervisory Control and Data Acquisition (SCADA) Systems:** Introduction to Supervisory Control and Data Acquisition (SCADA) systems; need and basic functions of SCADA; SCADA architecture and components, master station, Remote Terminal Units (RTUs), communication systems, and Human-Machine Interface (HMI); data acquisition and supervisory control functions; process visualization through graphical interfaces; alarm management and event handling; data logging and historical data trends; overview of communication protocols used in SCADA systems.

**Textbook(s):**


1. S.K. Singh, Industrial Instrumentation and Control, Tata McGraw-Hill Publishing Company, New Delhi, 2010.
2. S. Mukhopadhyay, S. Sen and A. K. Deb, Industrial Instrumentation, Control and Automation, Jaico Publishing House, 2012.


**Reference Book(S):**


1. Madhu Chanda Mitra, Samarjit Sen Gupta, "Programmable Logic Controllers and Industrial Automation: An Introduction", Penram International Publishing (India) Pvt. Ltd., 1 st Edition, 2008.
2. Fundamentals of Industrial Automation — Dr. Rajkumar Easwarapillai, Sree Raj M P, Dr. Bindu S S, Joe Jeba Rajan, Ashwin, SPI Publications, 2025.
3. SCADA: Supervisory Control and Data Acquisition – Stuart A. Boyer, ISA Publications.


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

https://nptel.ac.in/courses/108105062

| Course Articulation Matrix (CAM): | | U24EE802C : INDUSTRIAL AUTOMATION AND CONTROL | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE802C.1 | 3 | 2 | 1 | 2 | 2 | – | – | – | – | – | 1 | 2 | 1 |
| CO2 | U24EE802C.2 | 3 | 3 | 3 | 2 | 3 | – | – | – | – | – | 2 | 2 | 2 |
| CO3 | U24EE802C.3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | – | – | – | 2 | 2 | 3 |
| CO4 | U22EE702C.4 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | – | - | - | 2 | 2 | 3 |
| U24EE802C | | 3 | 2.75 | 2 | 2 | 2.5 | 1 | 1 | - | - | - | 1.75 | 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 | classify the components of industrial automation systems and analyze the characteristics of sensors, transducers, and measurement systems | SDG4 | Quality Education | Develops knowledge and technical competencies in industrial automation and control systems. |
| CO2 | Develop PLC-based solutions for sequence and logic control using appropriate programming techniques. | SDG8 | Decent Work and Economic Growth | Automation technologies improve industrial productivity, efficiency, and workforce capabilities. |
| CO3 | Analyze process control strategies and evaluate the role of Distributed Control Systems (DCS) in industrial process monitoring and control. | SDG9 | Industry, Innovation and Infrastructure | PLCs, DCS, SCADA, and automation systems are core technologies supporting modern industrial infrastructure and innovation. |
| CO4 | Analyze the architecture, components, and operational functions of SCADA systems for industrial monitoring and supervisory control. | SDG12 | Responsible Consumption and Production | Supports reliable and energy-efficient Process monitoring and control enable efficient use of energy, materials, and industrial resources. |

# SMART ELECTRIC GRID

| | | | |
|---|---|---|---|
| **Class:** B. Tech. VIII–Semester | | **Branch:** EEE | |
| **Course Code** | **U24EE803** | **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 architecture and challenges of Smart Grid systems.

**CO2 :** Apply computational tools and optimization techniques used in Smart Grid applications.

**CO3 :** Analyze distributed generation technologies, microgrids, and power quality aspects in Smart Grid.

**CO4 :** Apply communication technologies and control strategies used in Smart Grid systems.

| **UNIT-I** | **9 Hrs** |
|---|---|

**Introduction to Smart Grid**: Evolution of conventional power grid to Smart Grid – Definitions and concepts of Smart Grid – Features and functions of Smart Grid – Need for Smart Grid – Advantages and challenges of Smart Grid – Indian Smart Grid scenario and policies.

**Smart Grid Architecture**: Components and Architecture of Smart Grid Design –Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs – Transmission Automation – Distribution Automation –Renewable Integration

| **UNIT-II** | **9 Hrs** |
|---|---|

**Tools and Techniques for Smart Grid**: Computational techniques for Smart Grid – Static and dynamic optimization techniques – Computational intelligence techniques – Artificial intelligence applications – Evolutionary algorithms – Demand side management and energy management techniques.

| **UNIT-III** | **9 Hrs** |
|---|---|

**Distribution Generation Technologies**: Distributed generation technologies – Renewable energy integration – Microgrids and smart microgrids – Energy storage technologies – Electric vehicles and plug-in hybrid electric vehicles – Environmental impacts and climate change.

Power quality issues in Smart Grid – Power quality problems due to renewable energy integration – Power quality conditioners – Web-based power quality monitoring – Power quality audit.

| **UNIT-IV** | **9 Hrs** |
|---|---|

Communication technologies for Smart Grid – Smart sensors and intelligent electronic devices – Synchro phasor technology – Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS).

Control of Smart Grid systems – Load frequency control in microgrids – Voltage control in Smart Grid – Reactive power control – Demand response and energy management.

**Textbook(s):**

1. Bharat Modi, C.R. Balakrishna and N. Chandra Sekhar, *Fundamentals of Smart Grid Technology*, SK Kataria & Sons Publications.

**Reference Book(S):**

1. Mini S. Thomas and John D. McDonald, *Power System SCADA and Smart Grids*, CRC Press.
2. Stuart Borlase, *Smart Grids: Infrastructure, Technology and Solutions*, CRC Press.
3. A.G. Phadke and J.S. Thorp, *Synchronized Phasor Measurements and Their Applications*, Springer.

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

https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee84

| Course Articulation Matrix (CAM): | | U24EE803 SMART ELECTRIC GRID | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1 | U24EE803.1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | - | 1 | - | 1 | 2 | 2 |
| CO2 | U24EE803.2 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | - | 1 | - | 2 | 2 | 2 |
| CO3 | U24EE803.3 | 2 | 2 | 3 | 2 | 2 | 3 | 1 | - | 1 | 1 | 2 | 3 | 3 |
| CO4 | U24EE803.4 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | - | 1 | 1 | 2 | 3 | 3 |
| U24EE803 | | 2 | 2.5 | 2.25 | 2 | 2 | 2 | 1 | - | 1 | 1 | 1.75 | 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 | Explain the fundamentals, architecture and challenges of Smart Grid systems. | SDG7 | Affordable and Clean Energy | Smart grid concepts promote efficient, reliable, and sustainable electrical energy systems through intelligent monitoring, automation, and integration of clean energy resources. |
| CO2 | Describe computational tools and optimization techniques used in Smart Grid applications. | SDG9 | Industry, Innovation and Infrastructure | Smart grid computational tools, optimization methods, artificial intelligence, and automation technologies support innovation and modernization of power infrastructure. |
| CO3 | Illustrate distributed generation technologies, microgrids, and power quality aspects in Smart Grid. | SDG13 | Climate Action | Distributed generation technologies such as renewable energy systems, microgrids, electric vehicles, and storage technologies contribute to reduction of greenhouse gas emissions and support climate-resilient energy systems. |
| CO4 | Explain communication technologies and control strategies used in Smart Grid systems. | SDG11 | Sustainable Cities and Communities | Smart communication technologies, PMUs, WAMS, and intelligent control systems improve reliability, efficiency, and sustainability of urban power distribution systems and smart city infrastructure. |