# COURSE BOOK B. TECH. II YEAR

## Electrical & Computer Engineering

KIET GROUP OF INSTITUTIONS
www.kiet.edu
Delhi-NCR, Ghaziabad

KIET
GROUP OF INSTITUTIONS
Connecting Life with Learning

CELEBRATING 25 YEARS OF EXCELLENCE


# CURRICULUM STRUCTURE & SYLLABUS

## Effective from the Session: 2025-26

## B.Tech (ELCE) 3rd Sem

| S No. | Course Category (AICTE) | Course Category (UGC) | BOS | Course Code | Course Name | Type | Academic Learning (AL) | | | Continuous Internal Examination (CIE) | | | End Sem Examination (ESE) | Total Marks | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | MSE | CA | TOTAL | | CIE+ ESE | |
| 1 | PC | Major (Core) | ELCE | EL101L | Basic System Analysis | L | 2 | 0 | 0 | 40 | 10 | 50 | 50 | 100 | 2 |
| 2 | PC | Major (Core) | ELCE | EL102L | Circuit Analysis and Networks | L | 2 | 0 | 0 | 40 | 10 | 50 | 50 | 100 | 2 |
| 3 | BS | Major (Core) | ASH | MA105L | Probability and Statistics | L | 3 | 0 | 0 | 60 | 15 | 75 | 75 | 150 | 3 |
| 4 | PC | Major (Core) | ELCE | EL104L | Electrical Machines | L | 3 | 0 | 0 | 60 | 15 | 75 | 75 | 150 | 3 |
| 5 | MC | Value Added | ASH | HS109L | Constitution of India | L | 2 | 0 | 0 | 25 | - | 25 | 25 | - | NC |
| 6 | HS | AEC | ASH | HS110L | Aptitude-1 | L | 1 | 0 | 0 | - | 25 | 25 | 25 | 50 | 1 |
| 7 | HS | AEC | ASH | HS111L | Soft Skills Essential-1 | L | 1 | 0 | 0 | - | 25 | 25 | 25 | - | NC |
| **Blended** | | | | | | | | | | | | | | | |
| 8 | ES | Major (Core) | ELCE | EL106B | Introduction to AI & ML | B | 2 | 0 | 2 | 60 | 15 | 75 | 75 | 150 | 3 |
| 9 | PC | Major (Core) | ELCE | EL201B | Advanced Data Structures and Applications | B | 2 | 0 | 2 | 60 | 15 | 75 | 75 | 150 | 3 |
| 10 | PC | Major (core) | ELCE | EL103B | Morden Instrumentation and Data Acquisition | B | 1 | 0 | 2 | 40 | 10 | 50 | 50 | 100 | 2 |
| 11 | PE | Major (Core)/SEC | - | - | Professional Elective-I | B | 3 | 0 | 2 | 80 | 20 | 100 | 100 | 200 | 4 |
| **Lab/Practical** | | | | | | | | | | | | | | | |
| 12 | PC | Major (core) | ELCE | EL104P | Electrical Machines Lab | P | 0 | 0 | 2 | - | 25 | 25 | 25 | 50 | 1 |
| 13 | PW | Summer internship | CSIT | IT105P | Social Internship Assessment | P | 0 | 0 | 0 | - | 50 | 50 | - | 50 | 1 |
| **Total Hours : 32 hrs.** | | | | | | | **22** | **0** | **10** | | | | | **1250** | **25** |

## B. Tech (ELCE) 4th Sem

| S No. | Course Category (AICTE) | Course Category (UGC) | BOS | Course Code | Course Name | Type | Academic Learning (AL) | | | Continuous Internal Examination (CIE) | | | End Sem Examination (ESE) | Total Marks | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | L | T | P | MSE | CA | TOTAL | | CIE+ ESE | |
| 1 | PC | Major (Core) | ELCE | EL202L | Control Engineering | L | 3 | 0 | 0 | 60 | 15 | 75 | 75 | 150 | 3 |
| 2 | PC | Major (Core) | ELCE | EL203L | Electrical Power Systems | L | 3 | 0 | 0 | 60 | 15 | 75 | 75 | 150 | 3 |
| 3 | MC | Value Added | ASH | HS112L | Universal Human Values | L | 3 | 0 | 0 | 60 | 15 | 75 | 75 | 150 | 3 |
| 4 | HS | AEC | ASH | HS113L | Aptitude-2 | L | 1 | 0 | 0 | - | 25 | 25 | 25 | 50 | 1 |
| 5 | HS | AEC | ASH | HS114L | Soft Skills Essential 2 | L | 1 | 0 | 0 | - | 25 | 25 | 25 | - | NC |
| **Blended** | | | | | | | | | | | | | | | |
| 6 | PC | Major (Core) | CSIT | IT202B | Data Analytics | B | 2 | 0 | 2 | 60 | 15 | 75 | 75 | 150 | 3 |
| 7 | PC | Major (Core) | ELCE | EL204B | Object-Oriented Programming using C++ | B | 2 | 0 | 2 | 60 | 15 | 75 | 75 | 150 | 3 |
| 8 | PC | Major (Core) | ELCE | EL205B | Database Management and Operating Systems for Engineers | B | 2 | 0 | 2 | 60 | 15 | 75 | 75 | 150 | 3 |
| 9 | PE | Major (Core)/SEC | - | - | Professional Elective-II | B | 3 | 0 | 2 | 80 | 20 | 100 | 100 | 200 | 4 |
| **Lab/Practical** | | | | | | | | | | | | | | | |
| 10 | PC | Major (Core) | ELCE | EL202P | Control Engineering Lab | P | 0 | 0 | 2 | - | 25 | 25 | 25 | 50 | 1 |
| 11 | PC | Major (Core) | ELCE | EL203P | Electrical Power Systems Lab | P | 0 | 0 | 2 | - | 25 | 25 | 25 | 50 | 1 |
| **Total Hours : 32 hrs.** | | | | | | | **20** | **0** | **12** | | | | | **1250** | **25** |

### *Professional Electives (PE)*

| S.No. | Course Type (PE) | Basket-1 (AI and Data-Driven Smart Grid Technologies) Powered by: Tata Power DDL, Delhi | Basket-2 (Intelligent Electric Vehicle) Powered by: Imperial Society of Innovative Engineers and National Skill Development Corporation (NSDC) | Basket-3 (Next-Gen Automation: IIoT & Gateways) Powered by: Usha Automation, India and Phoenix Contact, Germany | Basket-4 Bio-Medical Electronics | Basket-5 VLSI Design |
|---|---|---|---|---|---|---|
| 1 | **BOS** | **ELCE** | **EEE** | **EEE** | **ECE** | **ECE** |
| | **PE I-(3rd Sem)** | Smart Grid Fundamentals and Applications (EL206E) | Modelling Dynamic Systems and Physical Components using MATLAB (EE205E) | Sensors & Automation Essentials (EE207E) | Biology For Engineers (EC210E) | Digital Integrated Circuit Design (EC212E) |
| 2 | **BOS** | **ELCE** | **EEE** | **EEE** | **ECE** | **ECE** |
| | **PE II-(4th Sem)** | AI and Machine Learning for Smart Grids (EL207E) | Integration of Systems of EVs (EE206E) | Integration of SCADA and PLC with IIOT Gateways (EE208E) | Bio-Medical Electronics & Devices (EC211E) | Analog Integrated Circuit Design (EC213E) |

# Theory Courses Detail Syllabus

| Course Code: EL101L | Course Name: Basic System Analysis | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**Pre-requisite:** Mathematics for System Analysis and Signal and System Basics

**Course Objectives:**

1. To understand the fundamental concepts of system analysis and their role in engineering applications.
2. To develop time-domain and frequency-domain analytical skills using Laplace and Fourier Transforms.
3. To study the state-space representation of linear time-invariant (LTI) systems.
4. To analyze discrete-time systems using Z-transforms.

**Course Outcome:** After completion of the course, the student will be able to

1. Explain the fundamentals of system analysis, including different types of systems and signal classifications.
2. Apply mathematical modeling techniques to engineering systems.
3. Analyze time-domain and frequency-domain response of first and second-order systems using various transforms.
4. Assess discrete-time system response and use of discrete-time convolution theorem.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 2 | - | - | - | - | - | - | - | - |
| CO2 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - |
| CO3 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - |
| CO4 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - |

| Unit 1 | Fundamentals of System Analysis | 08 hours |
|---|---|---|

Classification of signals and systems, standard test signals, signal operations, LTI systems, analogous systems.
MATLAB Application: Generating and visualizing basic signals, performing elementary signal operations (addition, scaling, time shifting) in MATLAB.

| Unit 2 | Fourier Transform Analysis | 08 hours |
|---|---|---|

Exponential and trigonometric forms of Fourier series, Fourier symmetry and Fourier integral, Fourier Transform of standard functions and periodic waveforms.
MATLAB Application: Computing and plotting Fourier series coefficients, calculating and visualizing Fourier Transforms of common signals using MATLAB.

| Unit 3 | Laplace Transform Analysis | 07 hours |
|---|---|---|

Review of Laplace Transform, Laplace Transform of periodic functions, Initial and Final Value Theorems, Inverse Laplace Transform, Convolution Theorem, Application of Laplace Transform to analysis of networks.
MATLAB Application: Solving differential equations using Laplace Transform in MATLAB (e.g., laplace, ilaplace), analyzing network responses, computation of Laplace and inverse Laplace transforms using Symbolic Math Toolbox.

| Unit 4 | Discrete-Time System Analysis | 07 hours |
|---|---|---|

Concept of Z-Transform, Z-Transform of common functions, Inverse Z-Transform, Initial and Final Value theorems, applications to solution of difference equations and pulse transfer function.
MATLAB Application: Computing and visualizing Z-Transforms, solving difference equations, and analyzing discrete-time systems using MATLAB's signal processing toolbox functions.

| Total Lecture Hours | 30 hours |
|---|---|

**Textbook:**

1. Oppenheim & Willsky, Signals and Systems, Prentice Hall.
2. A. Anand Kumar, Signals & Systems, PHI Learning.
3. B. P. Lathi, Linear Systems and Signals, Oxford University Press.
4. Nagrath & Gopal, Control Systems Engineering, New Age International.

**Reference Books:**

1. Van Valkenburg, Network Analysis, Prentice Hall.
2. Katsuhiko Ogata, Modern Control Engineering, Pearson.
3. Simon Haykin, Communication Systems, Wiley.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 20 | 20 | 4 | 4 | 2 | 50 | 100 |
| 40 | | 10 | | | | |

| Course Code: EL102L | Course Name: Circuit Analysis and Networks | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**Pre-requisite:** Fundamentals of engineering mathematics and basic knowledge of Electrical Circuits and Systems.

**Course Objectives:**
1. Understand the fundamental principles of circuit analysis and network theorems.
2. Analyse electrical circuits using mathematical techniques and systematic methods.
3. Evaluate steady-state and transient responses in electrical networks.
4. Investigate the parameters of two-port networks and filters.

**Course Outcome:** After completion of the course, the student will be able to
1. Understand the fundamentals of circuit analysis techniques.
2. Apply network theorems to analyze and solve electrical circuits.
3. Analyze steady-state and transient responses in electrical networks using mathematical techniques.
4. Evaluate two-port network and filter parameters and their applications.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO4 | 3 | 2 | - | - | - | - | - | - | - | - | - | - |

| Unit 1 | Basic Circuit Elements and Analysis | 07 hours |
|---|---|---|

Active and passive elements, ideal and practical sources, Circuit analysis using Mesh and Nodal methods (AC & DC circuits), Network theorems and Applications in linear AC and DC circuits, Duality principle in networks.

| Unit 2 | Two-Port Network Parameters | 07 hours |
|---|---|---|

Open-circuit and short-circuit parameters, Hybrid and transmission parameters, Interconnections of two-port networks, T & Π representation, Ladder and lattice networks.

| Unit 3 | Transient and Resonance Analysis | 08 hours |
|---|---|---|

Natural response and forced response, Transient response of RL, RC, and RLC circuits under DC excitation, Initial and Final conditions of circuit elements.

| Unit 4 | Filters | 08 hours |
|---|---|---|

Introduction and parameter evaluation of Low pass, high pass, band pass, band reject constant k-filters.

| Total Lecture Hours | 30 hours |
|---|---|

**Textbook:**
1. Van Valkenburg, M.E. – *Network Analysis*, Pearson Education.
2. Hayt, W.H., Kemmerly, J.E., & Durbin, S.M. – *Engineering Circuit Analysis*, McGraw-Hill Education.
3. Sudhakar, A., &Shyammohan S. Palli – *Circuits and Networks: Analysis and Synthesis*, McGraw-Hill Education.
4. Roy Choudhury, D. – *Networks and Systems*, New Age International Publishers.

**Reference Books:**
1. Desoer, C.A., &Kuh, E.S. – Basic Circuit Theory, McGraw-Hill Education.
2. Chakrabarti, A. – Circuit Theory (Analysis and Synthesis), Dhanpat Rai & Co.
3. Ghosh, S. – Network Theory: Analysis and Synthesis, PHI Learning.
4. Smarajit Ghosh – Network Theory, PHI Learning.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 20 | 20 | 4 | 4 | 2 | 50 | 100 |
| 40 | | 10 | | | | |

| Course Code: MA105L | Course Name: Probability & Statistics | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** X+2

**Course Objectives:**
1. To familiarize the graduate engineers with the concept of Statistics and Probability.
2. It aims to analyze the practical/ real life problems and solve them in scientific manner.

**Course Outcome:** After completion of the course, the student will be able to
1. Employ the concept of measure central tendency and regression analysis.
2. Apply knowledge of probability on distribution function.

3. Apply the concept of probability density function and normal distribution.
4. Apply the concept of random variable and time series.
5. Employ the knowledge of hypothesis by means of Chi-square and ANOVA test.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | - | - | - | - | 1 | - | - | - | 1 |
| CO2 | 2 | 2 | 2 | - | - | - | - | 1 | - | - | - | 1 |
| CO3 | 2 | 2 | 1 | - | - | - | - | 1 | - | - | - | 1 |
| CO4 | 2 | 2 | 1 | - | - | - | - | 1 | - | - | - | 1 |
| CO5 | 2 | 2 | 2 | - | - | - | - | 1 | - | - | - | 1 |

| **Unit 1** | **Basic Statistics** | **09 hours** |
|---|---|---|

Introduction to Descriptive Statistics, Measure of Central Tendency, Histogram in sampling, Method of least square (basic concept), Fitting of Straight line and exponential curve, Correlation, Rank correlation and Regression Analysis.

| **Unit 2** | **Probability I** | **09 hours** |
|---|---|---|

Probability, Law of total Probability, Conditional Probability, Baye's Theorem, Discrete Random Variable, Probability Mass function. Binomial Distribution, Poisson Distribution., Introduction to confusion matrix.

| **Unit 3** | **Probability II** | **09 hours** |
|---|---|---|

Continuous Random Variable, Probability density function, Properties of Probability density function, Expectation and variance, Normal Distribution and its applications.

| **Unit 4** | **Bivariate Random Variable and Time Series** | **09 hours** |
|---|---|---|

Introduction to two dimensional random variable, Joint probability density function and its properties, Marginal probability distribution, Introduction to Time series, component of time series, Measure of trend (Graphic method, method of Averages)

| **Unit 5** | **Sampling Theory** | **09 hours** |
|---|---|---|

Introduction to Inferential Statistics, Testing of Hypothesis: Introduction, Sampling Theory (Small and Large), Hypothesis, Null hypothesis, Alternative hypothesis, Testing a Hypothesis, Level of significance, Confidence limits, t-test, Chi-square test, one way analysis of variance (ANOVA).

| | **Total Lecture Hours** | **45 hours** |
|---|---|---|

**Textbook:**

1. B. V. Ramana, Higher Engineering Mathematics, McGraw-Hill Publishing Company Ltd., 2017
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2017.
3. R K. Jain & S R K. Iyenger, Advance Engineering Mathematics, Narosa Publishing House 2002.
4. S. C. Gupta & V. K. Kapoor, Fundamental of Mathematical Statistics, Sultan Chand & Sons.

**Reference Books:**

1. Seymour Lipschutz, John Schiller, Introduction to Probability and Statistics, McGraw Hill
2. Peter V. O'Neil, Advance Engineering Mathematics, Thomson (Cengage) Learning, 2007.
3. TKV Iyenger, B. Krishna Gandhi, S. Ranganatham, MVSN Prasad, Probability and Statistics (S. Chand Publishing House).
4. E. Kreyszig, Advance Engineering Mathematics, John Wiley & Sons, 2005.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 30 | 30 | 6 | 6 | 3 | 75 | 150 |
| 60 | | 15 | | | | |

| **Course Code: EL104L** | **Course Name: Electrical Machines** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**Pre-requisite:** Basic electrical engineering concepts, circuit analysis and electromagnetic theory.

**Course Objectives:**

1. To understand the principles of electromechanical energy conversion for electrical machines.
2. To analyze the performance characteristics and applications of power transformers in industry.
3. To study the construction, equivalent circuits, and control techniques of induction machines.
4. To explore the characteristics, and operation of synchronous machines, including special motors.
5. To examine modern applications of electrical machines in renewable energy, electric vehicles, robotics, and industrial automation.

**Course Outcome:** After completion of the course, the student will be able to

1. Explain the energy conversion principles and analyze force and torque production in rotating machines.
2. Evaluate the performance parameters of dc machines and power transformers in industrial applications.
3. Analyze the performance characteristics of induction-based machines and their role in HVAC systems.
4. Examine performance of synchronous and special machines.
5. Assess the role of electrical machines in emerging technologies such as EVs, smart grids, and automation.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 1 | - | - | - | 1 | - | - | - | 1 | - |
| CO2 | 3 | 1 | 1 | - | - | - | 1 | - | - | - | 1 | - |
| CO3 | 3 | 1 | 1 | - | - | - | 1 | - | - | - | 1 | - |
| CO4 | 3 | 1 | 1 | - | - | - | 1 | - | - | - | 1 | - |
| CO5 | 3 | 1 | - | - | - | 1 | 1 | - | - | - | 1 | - |

| **Unit 1** | **Energy Conversion Principles & DC Machines** | **09 hours** |
|---|---|---|

AC circuits & Magnetic Circuits, Faraday's Law & Electromagnetic Induction, Construction and working principle: DC machines, EMF equation, types, characteristics and applications. **Matlab applications:** Simulink model of DC machine and observe speed vs voltage.

| **Unit 2** | **Transformer** | **09 hours** |
|---|---|---|

Working Principle and EMF equation of transformer. Ideal and Practical transformer model, Equivalent Circuit and Phasor Diagram, Voltage regulation and efficiency, No-load and short-circuit tests, Auto Transformers, Three-Phase Transformers, Phasor groups, Application of transformers in industry. **Matlab applications:** Simulate no-load and short-circuit test in Matlab.

| **Unit 3** | **Induction Machines** | **09 hours** |
|---|---|---|

Construction, principle of operation, winding factor, revolving magnetic field theory, Equivalent circuit and performance analysis, Power and Torque expression, Torque-speed Characteristics, Starting, regenerative and dynamic braking and Speed control, Introduction to induction generator, Variable frequency drives.

| **Unit 4** | **Synchronous Machines** | **09 hours** |
|---|---|---|

Types, construction, working principle, equivalent circuit, characteristics, phasor diagram and applications, V and inverted V Characteristics of synchronous motors and synchronous machine stability. Parallel operation of alternators.

| **Unit 5** | **Emerging Advances and Industrial Applications** | **09 hours** |
|---|---|---|

Electrical Machines in Renewable Energy Systems, Electric Transportation (EVs, Railways, and Aerospace), Fractional-HP and Special Machines: PMDC motors, PMSG, BLDC, Switched Reluctance Motor, single phase induction motor.

| **Total Lecture Hours** | **45 hours** |
|---|---|

**Textbook:**

1. P.S. Bimbhra, "Electrical Machinery," Khanna Publishers.
2. E. Fitzgerald, C. Kingsley, S. D. Umans, "Electric Machinery," McGraw Hill.
3. M. G. Say, "Performance and Design of AC Machines," CBS Publishers.
4. E.G. Janardhanan, "Electrical Machines: Analysis, Design, and Applications," Wiley.

**Reference Books:**

1. P. C. Sen, "Principles of Electrical Machines and Power Electronics," Wiley.
2. S. J. Chapman, "Electric Machinery Fundamentals," McGraw Hill.
3. G. K. Dubey, "Fundamentals of Electrical Drives," Narosa Publishing.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 30 | 30 | 6 | 6 | 3 | 75 | 150 |
| 60 | | 15 | | | | |

| Course Code: HS109L | Course Name: Constitution of India | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | NC |

**Pre-requisite:** NA

**Course Objectives:**

1. To acquaint the students with legacies of constitutional development in India and help those to understand the most diversified legal document of India and philosophy behind it.
2. To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
3. To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.

4. To learn procedure and effects of emergency, composition and activities of election commission and amendment procedure.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand basic features and modalities about Indian constitution.
2. Clarify the functioning of Indian parliamentary system at the center and state level.
3. Understand the aspects of Indian Legal System and its related bodies.
4. Apply different laws and regulations related to engineering practices.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | - | 1 | 2 | - | - | - | 2 |
| CO2 | - | - | - | - | - | - | 1 | 1 | 1 | - | - | 2 |
| CO3 | - | - | - | - | - | - | 1 | 1 | 1 | - | 1 | 2 |
| CO4 | - | - | - | - | - | - | 1 | 2 | 1 | 1 | 1 | 2 |

| **Unit 1** | **Basic Information about Indian Constitution** | **08 hours** |
|---|---|---|

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947, Enforcement of the Constitution, Indian Constitution and its Salient Features, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

| **Unit 2** | **Union Executive and State Executive** | **08 hours** |
|---|---|---|

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Judicial Activism, Lok Pal, Lok Ayukta, The Lokpal and Lok ayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

| **Unit 3** | **Basic Information about Legal System** | **07 hours** |
|---|---|---|

The Legal System: Sources of Law and the Court Structure: Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law, Principles taken from decisions of judges constitute binding legal rules. The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court). Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration. Contract law, Tort, Law at workplace.

| **Unit 4** | **Election provisions, Emergency provisions, Amendment of the constitution** | **07 hours** |
|---|---|---|

Election Commission of India-composition, powers and functions and electoral process. Types of emergency-grounds, procedure, duration and effects. Amendment of the constitution- meaning, procedure and limitations

| | **Total Lecture Hours** | **30 hours** |
|---|---|---|

**Textbook:**


1. Brij Kishore Sharma: *Introduction to the Indian Constitution*, 8th Edition, PHI Learning Pvt. Ltd.
2. Granville Austin: *The Indian Constitution: Cornerstone of a Nation (Classic Reissue)*, Oxford University Press.
3. S.G Subramanian: *Indian Constitution and Indian Polity*, 2nd Edition, Pearson Education 2020.
4. Subhash C. Kashyap: *Our Constitution: An Introduction to India's Constitution and constitutional Law*, NBT, 2018.
5. Madhav Khosla: *The Indian Constitution*, Oxford University Press.
6. PM Bakshi: *The Constitution of India*, Latest Edition, Universal Law Publishing.
7. V.K. Ahuja: *Law Relating to Intellectual Property Rights* (2007)
8. Suresh T. Viswanathan: *The Indian Cyber Laws, Bharat Law House*, New Delhi-88
9. P. Narayan: Intellectual Property Law, Eastern Law House, New Delhi
10. Executive programme study material Company Law, Module II, by ICSI (The Institute of Companies Secretaries of India) (Only relevant sections i.e., Study 1, 4 and 36).https://www.icsi.edu/media/webmodules/publications/Company%20Law.pdf
11. Handbook on e-Governance Project Lifecycle, Department of Electronics & Information Technology, Government of India, https://www.meity.gov.in/writereaddata/files/e- Governance_Project_Lifecycle_Participant_Handbook-5Day_CourseV1_20412.pdf
12. Companies Act, 2013 Key highlights and analysis by PWC. https://www.pwc.in/assets/pdfs/publications/2013/companies-act-2013-key-highlights- and-analysis.pdf

**Reference Books:**


1. Keshavanand Bharati V. State of Kerala, AIR 1973 SC 1461.
2. Maneka Gandhi V. Union of India AIR, 1978 SC 597.
3. S.R. Bammai V. Union of India, AIR 1994 SC 1918.
4. Kuldip Nayyar V. Union of India, AIR 2006 SC312.
5. A.D.M. Jabalpur V. ShivkantShakla, AIR 1976 SC1207.
6. Remshwar Prasad V. Union of India, AIR 2006 SC980.
7. Keshav Singh in re, AIR 1965 SC 745.
8. Union of India V. Talsiram, AIR 1985 SC 1416.
9. Atiabari Tea Estate Co.V. State of Assam, AIR 1961SC232.
10. SBP & Co. Vs. Patel Engg. Ltd. 2005 (8) SCC 618.
11. Krishna Bhagya Jala Nigam Ltd. Vs. G. Arischandra Reddy (2007) 2 SCC 720.
12. Oil & Natural Gas Corporation Vs. Saw Pipes Ltd. 2003 (4) SCALE 92 – 185.
13. Contemporary Newer case studies can be developed using AI tools
14. ** (Other relevant case studies can be consulted by the teacher as per the topic). Prescribed Legislations:
15. Information Technology Act, 2000 with latest amendments. **Compare this with GDPR of Europe**
16. RTI Act 2005 with latest amendments.
17. Information Technology Rules, 2000
18. Cyber Regulation Appellate Tribunal Rules, 2000 Suggested aid for Students and Pedagogic purpose
19. RSTV debates on corporate law, IPR and patent issues
20. NPTEL lectures on IPR and patent rights


**Episodes of 10 -part mini TV series "Samvidhan: The Making of Constitution of India" by RSTV.**

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total | |
|---|---|---|---|---|---|---|---|
| MSE | MSE2 | CA1 | CA2 | CA4 (ATT) | | | |
| - | 25 | - | - | - | 25 | NC | |
| 25 | | - | | | | | |

| Course Code: HS110L | Course Name: Aptitude-1 | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | 1 |

**Pre-requisite:** NA

**Course Objectives:**

1. To provide adequate exposure to the students regarding the use of aptitude tests in the recruitment process and competitive examinations.
2. To improve the logical & numerical ability of the students.

**Course Outcome:** After completion of the course, the student will be able to

1. Illustrate their comprehension by solving the given problems
2. Apply the learned concepts to new problems and solve them aptly.
3. Make use of their thought process to interpret and draw inferences from the given data to reach logical conclusions.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | 1 | - | 1 | - | - | - | - | - | 1 |
| CO2 | 1 | 1 | - | 1 | - | 2 | - | - | - | - | - | 1 |
| CO3 | 1 | 1 | - | 1 | - | 1 | - | - | - | - | - | 2 |

| Unit 1 | Series, Coding and Decoding | 04 hours |
|---|---|---|

Importance and overview of Quantitative Aptitude and Logical Reasoning, Number Series, Letter Series, Analogies, Coding and Decoding.

| Unit 2 | Data Arrangement | 04 hours |
|---|---|---|

Ranking and Order, Direction Sense, Linear and Circular sitting arrangement.

| Unit 3 | Blood Relation and Puzzles | 03 hours |
|---|---|---|

Basic concepts, definition and terminology related to blood relationships, Conversation-based blood relationships, Family Tree-based problems, Coded relationships and related puzzles.

| Unit 4 | Critical and Non-Verbal Reasoning | 04 hours |
|---|---|---|

Statement arguments, course of action, classification and grouping of images, Figure series, Mirror image, Water image, Paper cutting, Paper folding, Embedded figures.

| | |
|---|---|
| **Total Lecture Hours** | **15 hours** |

**Textbook:**
1. A Modern Approach to Verbal & Non-Verbal Reasoning" by R.S. Aggarwal, S. Chand Publication.

**Reference Books:**
1. How to Prepare for Logical Reasoning for the CAT" by Arun Sharma, TMH Publication.

**Mode of Evaluation:**

| CA | | | ESE | Total |
|---|---|---|---|---|
| CA1 | CA2 | CA3(ATT) | | |
| 10 | 10 | 5 | 25 | 50 |
| 25 | | | | |

| Course Code: HS111L | Course Name: Soft Skills Essentials-1 | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | NC |

**Pre-requisite:**
- Students should have foundational knowledge of grammar, vocabulary, and sentence structure to participate effectively in tasks like extempore, scenario writing after studying Communication skills subject in first year.
- Prior exposure to basic communication concepts (like verbal/non-verbal communication and listening skills) helps students to enhance persuasion, negotiation, and professional etiquette.

**Course Objectives:**

To develop students' communication, presentation, and interpersonal skills through interactive activities, elevating confidence and professionalism for academic and workplace success

**Course Outcome:** After completion of the course, the student will be able to
1. Demonstrate improved self-awareness and communication skills through structured presentations and vocabulary-building activities.
2. Apply effective verbal communication techniques, including pronunciation and elevator pitch delivery, to express ideas clearly and confidently.
3. Exhibit professional behaviour, grooming, and teamwork skills in group discussions, interviews, and workplace-related role plays.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | - | - | - | 2 | 3 | - | 1 |
| CO2 | - | - | - | - | - | - | - | - | 2 | 3 | - | 2 |
| CO3 | - | - | - | - | - | - | - | - | 2 | 3 | - | 2 |

| Unit 1 | Foundation of Communication and Self-Awareness | 05 hours |
|---|---|---|

British Council-English Score Test, Team Presentations on Change Management Models, Presentations on Personality Profiling for professional growth

| Unit 2 | Verbal Communication and Clarity | 04 hours |
|---|---|---|

Pronunciation Drill 1 & 2, Elevator Pitch Practice Session 1 & 2

| Unit 3 | Professionalism and Workplace Readiness | 06 hours |
|---|---|---|

Professional Grooming and Etiquette, Group Discussion (General Topics ), Panel Discussion on workplace scenarios using caselets

| | |
|---|---|
| **Total Lecture Hours** | **15 hours** |

**Useful Resources:**
1. www.mindtools.com
2. https://englishonline.britishcouncil.org/
3. www.toastmasters.org
4. https://www.futurelearn.com/
5. English Score Test
6. Duo Lingo Test

**Mode of Evaluation**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| - | - | 10 | 10 | 5 | | |
| - | | 25 | | | 25 | 50 |

| Course Code: EL106B | Course Name: Introduction to AI & ML | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**Pre-requisite:** Knowledge of Mathematics in Secondary Education and basic Programming skills

**Course Objectives:**
Provide core engineering students with a foundational understanding of artificial intelligence, machine learning, and reinforcement learning, with practical implementation skills using Python.

**Course Outcome:** After completion of the course, the student will be able to
1. Understand fundamental concepts of AI and implement basic search algorithms
2. Apply various machine learning algorithms to solve real-world problems
3. Develop deep learning models using modern frameworks
4. Implement reinforcement learning algorithms for decision-making problems
5. Create end-to-end machine learning projects using Python.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | - | - | - | 2 | 1 | - | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | 2 | 1 | - | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | - | - | - | 2 | 1 | - | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | - | - | - | 2 | 1 | - | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | - | 2 | 1 | - | 3 |

**Unit 1 | Introduction to Artificial Intelligence | 12 hours**

Introduction to Artificial Intelligence, Types of AI: Weak AI vs Strong AI, Problem Solving and Search Algorithms- State Space Search, Uninformed Search Strategies (BFS, DFS), Informed Search Strategies (A*, Best First Search)

**Problems:**
- Write a program to simulate a simple rule-based chatbot using if-else or pattern matching.
- Write a program to compare Weak AI and Strong AI through Tic-Tac-Toe and a basic Turing Test interface.
- Write a program to generate and display the state space tree for the 8-puzzle problem up to a certain depth.
- Write a program to implement Best First Search using a heuristic function to guide the search.
- Write a program to implement the A* algorithm for pathfinding in a weighted graph or grid.

**Unit 2 | Introduction to Machine Learning | 12 hours**

Fundamentals of Machine Learning, Supervised vs Unsupervised Learning, Training, Validation, and Testing. Data Preprocessing- Data Cleaning, Feature Scaling, Feature Selection, Handling Missing Values. Linear Regression and Logistic Regression

**Problems:**
- Write a program to demonstrate the difference between Supervised and Unsupervised Learning using appropriate datasets.
- Write a program that splits a dataset into training, validation, and test sets and prints their sizes.
- Write a program to clean a dataset by removing duplicates, handling missing values, and encoding categorical features.
- Write a program to apply feature scaling using StandardScaler and MinMaxScaler on numerical data.
- Write a program to perform feature selection using correlation matrix and SelectKBest method.
- Write a program to implement Linear Regression on a dataset and evaluate its performance using RMSE and $R^2$ score.

**Unit 3 | Advanced Machine Learning Algorithms | 10 hours**

K-Means Clustering, Support Vector Machines- Linear and Non-linear SVM, Kernel Functions, Decision Trees and Random Forests,

**Problems:**
- Write a program to implement K-Means clustering on a dataset and visualize the clusters.
- Write a program to train a Linear SVM classifier on the Iris dataset and evaluate its accuracy.
- Write a program to implement a Non-Linear SVM classifier using a radial basis function (RBF) kernel.
- Write a program to demonstrate the effect of different kernel functions (linear, polynomial, RBF) on SVM performance.
- Write a program to implement a decision tree classifier and visualize the decision tree

**Unit 4 | Reinforcement Learning | 13 hours**

Fundamentals of Reinforcement Learning- Markov Decision Processes, States, Actions, and Rewards, Value Functions and Policies. Q-Learning- Q-Table and Q-Function, Exploration vs Exploitation, Epsilon-Greedy Strategy. Applications in Gaming and Robotics

**Problems:**

- Write a program to simulate a simple Markov Decision Process (MDP) with 3 states and 2 actions. Show state transitions and rewards using a transition probability matrix.
- Write a program to implement Q-Learning for a small grid environment (e.g., 4x4 frozen lake). Use a Q-table to learn the best actions from each state.
- Write a program to compare the effect of different exploration strategies (greedy, epsilon-greedy, and softmax) on the learning process in Q-Learning.
- Write a program where an agent learns to play a simple game (e.g., Tic-Tac-Toe or a custom maze) using Q-learning
- Write a program to visualize how Q-values evolve over time in a simple environment using Epsilon-Greedy strategy with decay

| **Unit 5** | **Deep Learning** | **13 hours** |
|---|---|---|

Neural Networks Basics- Perceptron, Activation Functions, Backpropagation, Multi-layer Neural Networks, Introduction to Convolutional Neural Networks, Introduction to Recurrent Neural Networks- RNN Architecture, LSTM and GRU, Sequence Prediction. Deep Learning Frameworks- Introduction to TensorFlow, Model Building and Training.

**Problems**

- Write a program to implement a single-layer Perceptron for binary classification.
- Write a program to plot and compare common activation functions (Sigmoid, Tanh, ReLU, Leaky ReLU).
- Write a program to implement backpropagation in a multi-layer feedforward neural network from scratch.
- Write a program to build and train a neural network using TensorFlow's Keras API for a classification task.

| **Total Lecture Hours** | **60 hours** |
|---|---|

**Textbook:**


1. S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 4th ed. Upper Saddle River, NJ, USA: Pearson, 2020.
2. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.
3. R. S. Sutton and A. G. Barto, *Reinforcement Learning: An Introduction*, 2nd ed. Cambridge, MA, USA: MIT Press, 2018.


**Reference Books:**


1. C. M. Bishop, *Pattern Recognition and Machine Learning*. New York, NY, USA: Springer, 2006.
2. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016.
3. S. Raschka and V. Mirjalili, *Python Machine Learning*, 2nd ed. Birmingham, UK: Packt Publishing, 2017.
4. T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, 2nd ed. New York, NY, USA: Springer, 2009.


**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 30 | 30 | 6 | 6 | 3 | 75 | 150 |
| 60 | | 15 | | | | |

| **Course Code: EL201B** | **Course Name: Advanced Data Structures and Applications** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **2** | **0** | **2** | **3** |

**Pre-requisite:** Data Structure

**Course Objectives:**

1. Understand and implement fundamental data structures for efficient data storage and retrieval.
2. Analyze and apply advanced data structures for solving complex computational problems.

**Course Outcome:** After completion of the course, the student will be able to

1. Implement and manipulate basic data structures such as arrays, linked lists, stacks, and queues.
2. Apply tree structures and traversal techniques to solve computational problems.
3. Implement graph algorithms for searching, spanning trees, and shortest path computation.
4. Utilize hashing techniques for efficient data retrieval and storage.
5. Apply heap structures for priority-based problem-solving and memory management.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | - | 2 | - | - | - | - | 1 | - | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 1 | - | 2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | 3 | 3 | 2 | 2 | 2 | - | 2 | - | - | 1 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | 2 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 1 | 2 | 2 |

| **Unit 1** | **Introduction to Fundamental Data Structures** | **10 hours** |
|---|---|---|

Introduction to Array, Linked List: Single, Doubly, Circular Linked List and Circular Doubly Linked List. Stack, Stack Operation, Queue, Queue Operation, Circular Queue, Deque.

- Implement singly, doubly, circular singly, and circular doubly linked lists with basic operations (insert, delete, search, display).
- Create a priority queue using an array or linked list where elements are dequeued based on priority.
- Implement Stack using a linked list.
- Implement a circular queue with proper handling of front and rear pointers.
- Write a program to reverse stack using recursion.

| **Unit 2** | **Trees** | **14 hours** |
|---|---|---|

Introduction to Trees, Application of Trees, Tree Traversal Techniques: In Order Traversal, Preorder Traversal, Post order Traversal, Level Order Traversal, Binary Tree, Binary Search Tree, AVL Tree: Rotation, Balance Factor, Insertion and Deletion, Multi way trees: B-tree, Operation: insertion, deletion, search, B+ tree.

- Build a binary tree and implement in-order, pre-order, post-order, and level-order traversals.
- Implement a BST with insertion, deletion, and search operations.
- Implement an AVL tree with all types of rotations (LL, RR, LR, RL). Show balance factor updates.
- Write a function to calculate the height and depth of nodes in a binary tree.
- Recursively convert a binary tree to its mirror image.

| **Unit 3** | **Graph** | **14 hours** |
|---|---|---|

Introduction to Graph, Application of Graph, Graph Representations, Breadth First Traversal, Depth First Traversal, Minimum Spanning Trees (Kruskal's and Prim's Algorithm), Connected Component, Topological sort.

- Implement a graph using both adjacency matrix and adjacency list.
- Implement breadth-first search (BFS) and depth-first search (DFS) on a graph.
- Implement Kruskal's and Prim's algorithms on a weighted undirected graph.
- Write a program to count and display all connected components in an undirected graph using DFS.
- Implement topological sort using DFS.

| **Unit 4** | **Hashing and Hash Table Technique** | **10 hours** |
|---|---|---|

Introduction to Hashing, Need for Hashing, Hash Functions, Properties of a Good Hash Function, Hash Tables, Load Factor.

- Implement a basic hash table with a simple hash function and handle collisions using chaining.
- Write a program that inserts elements into a hash table and computes the load factor.
- Implement linear probing, quadratic probing, and double hashing for collision resolution.
- Given an array of integers, find the frequency of each distinct element using hashing and return a map of element to its count.
- Given an array and an integer *k*, check whether the array contains duplicate elements within a distance *k* from each other using hashing.

| **Unit 5** | **Heaps and Heap Implementation** | **12 hours** |
|---|---|---|

Definition and Properties of Heaps, Max Heap vs. Min Heap, Array Representation of Heaps, Heap Operations (Insertion, Deletion, Heapify), Build Heap (Bottom-Up and Top-Down Approaches).

- Implement both Max Heap and Min Heap using array representation. Include insertion and deletion.
- Demonstrate both bottom-up and top-down approaches to build a heap from an unsorted array.
- Use a heap to sort an array of numbers in ascending and descending order.
- Create a priority queue using a min-heap. Include insertion and removal with priorities.
- Write a program to find the **k largest elements** in an array using a Min Heap of size k.
- Use a Min Heap to merge k sorted arrays into one sorted output efficiently.

| | **Total Lecture Hours** | **60 hours** |
|---|---|---|

**Textbook:**

1. Introduction to Algorithm, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford SteinGrady Booch
2. Algorithms Unlocked, Thomas H. Cormen
3. The Algorithm Design Manual, Steven S. Skiena

**Reference Books:**

1. Rajesh K. Shukla, "Data Structure Using C and C++" Wiley Dreamtech Publication.
2. Jean Paul Trembley and Paul G. Sorenson, "An Introduction to Data Structures with applications", McGraw Hill.

3. Berztiss, A.T.: Data structures, Theory and Practice, Academic Press
4. P.S. Deshpandey, "C and Data Structure", Wiley Dreamtech Publication

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 30 | 30 | 6 | 6 | 3 | 75 | 150 |
| 60 | | 15 | | | | |

| Course Code: EL103B | Course Name: Modern Instrumentation and Data Acquisition | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 2 | 2 |

**Pre-requisite:** Basic knowledge of Electrical & Electronics Engineering, Digital Electronics

**Course Objectives:**

1. Understand the principles of modern measurement systems and instrumentation.
2. Understand different types of sensors and transducers.
3. Explore the working of electrical and electronic measuring instruments.
4. Explore uses of intelligent sensors and virtual instrumentation in data acquisition systems.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand the fundamentals of measurement systems, calibration techniques, and error analysis.
2. Apply the principles of sensors and transducers for measuring physical parameters.
3. Apply electrical and electronic measuring instruments for signal measurement and analysis.
4. Analyze signal conditioning techniques and virtual instrumentation for data acquisition systems.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | - | - | - | - | 1 | - | - | - |
| CO2 | 3 | 2 | 1 | - | - | - | - | - | 1 | - | - | - |
| CO3 | 3 | 2 | 1 | 1 | - | - | - | - | 1 | - | - | - |
| CO4 | 3 | 2 | 1 | 1 | 3 | - | - | - | 1 | - | - | - |

**Unit 1 Fundamentals of Measurement & Instrumentation** — **10 hours**

Basics of Measurement, Characteristics of instruments, Errors in Measurement, Calibration of Instruments,

**Activities:**

- Understand the principles of standards, static characteristics, and error calculation.
- Evaluate dynamic characteristics (time constant, response time) using an RC circuit.

**Unit 2 Electrical and Electronic Instruments** — **15 hours**

Introduction to Analog instruments (PMMC), Introduction to Digital instruments: (Digital voltmeter), digital storage oscilloscope (DSO), Power and energy measurement (Wattmeter), Instrument transformers (CTs and PTs)

**Activities:**

- Understand and practice using a Cathode Ray Oscilloscope (CRO) to measure waveform parameters.
- Calibration of Energy meter using two watt meter method

**Unit 3 Signal Conditioning & Data Acquisition** — **10 hours**

Amplifiers (op-amp-based), Analog-to-digital and digital-to-analog conversion, Sampling, quantization, resolution, Block diagram and interfacing of Data acquisition systems (DAS)

**Activities:**

- Design and test basic inverting and non-inverting op-amp amplifier circuits.
- Build a basic signal conditioning circuit for sensor inputs.

**Unit 4 Intelligent Sensors & Virtual Instrumentation** — **10 hours**

Features of smart sensors, Self-calibration, self-testing, Communication protocols, GPIB, RS-232, RS-485, USB

**Activities:**

- Analyze Smart Sensor Capabilities
- Data Acquisition and Control via USB and GPIB Interfaces

**Total Lecture Hours** — **45 hours**

**Textbook:**

1. DVS Murthy, "Transducers and Instrumentation," PHI, 2nd Edition, 2013.
2. D. Patranabis, "Sensors and Transducers," PHI, 2nd Edition, 2013.
3. S. Gupta, J.P. Gupta, "PC Interfacing for Data Acquisition & Process Control," ISA, 1994.
4. Gary Johnson, "LabVIEW Graphical Programming," McGraw Hill, 2nd Edition, 1997.

**Reference Books:**

1. Arun K. Ghosh, "Introduction to Measurements and Instrumentation," PHI, 4th Edition, 2012.
2. A.D. Helfrick, W.D. Cooper, "Modern Electronic Instrumentation & Measurement Techniques," PHI, 2001.
3. Hermann K.P. Neubert, "Instrument Transducers," 2nd Edition, Oxford University Press, 2012.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 20 | 20 | 4 | 4 | 2 | 50 | 100 |
| 40 | | 10 | | | | |

| Course Code: EL206E | Course Name: Smart Grid Fundamentals and Applications | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**Pre-requisite:** NA

**Course Objectives:**

1. To provide a foundational understanding of the Smart Grid and its architecture.
2. To introduce key enabling technologies like AI/ML, AMI, PMUs, IoT, and cyber-physical systems in smart grids.
3. To demonstrate the integration of renewable energy sources and distributed generation in the modern grid.
4. To impart skills for data-driven analysis, fault detection, and demand-response systems.
5. To expose students to industry practices through Tata Power-DDL use cases and real-world implementations.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand the core architecture, features, and components of a Smart Grid.
2. Explain the role of ICT, AMI, and data acquisition in modern energy systems.
3. Apply AI/ML techniques for load forecasting, fault diagnosis, and predictive maintenance.
4. Analyze and evaluate case studies and deployment strategies in Smart Grid applications.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 3 | - | - | - | - | 1 | - | 1 |
| CO2 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | 1 | - | 2 |
| CO3 | 2 | 3 | 3 | 3 | 3 | - | - | - | - | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 3 | 1 | - | - | - | 2 | 2 | 3 |

**Unit 1 | Smart Grid Concepts and Architecture | 19 hours**

Conventional grid vs. smart grid, Smart grid functions and benefits, Smart grid architecture: generation, transmission, distribution, DERs, Roles of utilities, prosumers, and regulators, Smart Grid Components (smart meters, sensors, energy management systems), Distributed Generation (DG), microgrids, and virtual power plants (VPPs).

**Activities:**

- Simulate power flow for both traditional and smart grid models in MATLAB/Simulink.
- Visualize smart grid parameters (voltage, current, frequency) using SCADA platforms.

**Unit 2 | Enabling Technologies in Smart Grid | 19 hours**

Smart meters and their functionality, Advanced Metering Infrastructure (AMI), AMI components (HAN, NAN, WAN), Communication protocols (ZigBee, RF Mesh, Power Line Communication), 5G, Interoperability and data standards, Phasor Measurement Units (PMUs), SCADA, Smart substations, and remote terminal units.

**Activities:**

- Load forecasting using regression and neural networks Activities
- Simulate or import sample smart meter data (e.g., hourly consumption) in Python or Excel.
- Interface sensors with microcontrollers to emulate energy monitoring and wireless data transmission.

**Unit 3 | Data Analytics and AI/ML Applications | 19 hours**

Data acquisition and preprocessing for Smart Grids, Load forecasting using ML (regression, neural networks), Fault detection and diagnostics, Demand response, load shaping, and predictive maintenance using AI/ML

**Activities:**

- Use historical data to forecast short-term load demand using linear regression in Python.
- Apply FFT in MATLAB or Python on current/voltage signals to detect abnormal grid behavior.

**Unit 4 | Real-World Applications and Case Studies | 18 hours**

Tata Power DDL Delhi Smart Grid initiatives, Real-time pricing and smart billing systems, Cybersecurity and privacy concerns in smart grid environments, Regulatory framework, standards (IEEE 1547, IEC 61850), and policy interventions.

**Activities:**

- Simulate dynamic pricing algorithms based on grid demand and implement a simple billing system.

- Develop a dashboard or chart showing the evolution of smart grid policies (e.g., IEEE 1547 compliance) and their technical implications.

| Total Lecture Hours | 75 hours |
|---|---|

**Textbook:**
1. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley
2. S. M. Islam, Smart Grid Systems: Modeling and Control, CRC Press.

**Reference Books:**
1. Krzysztof (Kris) Iniewski, Smart Grid Infrastructure & Networking, McGraw-Hill
2. Elissaios Sarmas, Vangelis Marinakis, Haris Doukas, Artificial Intelligence for Energy Systems (Driving Intelligent, Flexible and Optimal Energy Management), Springer
3. Tata Power-DDL Whitepapers, Technical Reports, and Use Cases.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

| Course Code: EC210E | Course Name: Biology for Engineers | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**Pre-requisite:** NA

**Course Objectives:**
1. To introduce students to modern biology with emphasis on evolution of biology as a multi-disciplinary field
2. To make them aware of application of engineering principles in biology
3. To create engineering robust solutions inspired by biological examples

**Course Outcome:** After completion of the course, the student will be able to
1. Apply the concepts of biology in electronics applications
2. Understand the function of Human Organ Systems.
3. Understand the functional architecture of Nature-Bioinspired Materials.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 2 | 1 | 3 | - | - | - | - | - | - | - |
| CO2 | 1 | 2 | 3 | 2 | 1 | - | - | - | - | - | - | - |
| CO3 | 2 | 2 | 3 | 3 | 3 | - | - | - | - | - | - | 2 |
| CO4 | 1 | 1 | 3 | 1 | 3 | 2 | - | - | - | - | 1 | 2 |

| Unit 1 | HUMAN ORGAN SYSTEMS AND BIO DESIGNS-1 | 19 hours |
|---|---|---|

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye), Heart as a pump system (architecture, electrical signaling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators)

| Unit 2 | HUMAN ORGAN SYSTEMS AND BIO-DESIGNS-2 | 19 hours |
|---|---|---|

Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine), Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis)

| Unit 3 | NATURE-BIOINSPIRED MATERIALS AND MECHANISMS | 19 hours |
|---|---|---|

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

| Unit 4 | TRENDS IN BIOENGINEERING | 18 hours |
|---|---|---|

Bioprinting techniques and materials, 3D printing of ear, bone and skin. Electrical tongue and electrical nose in food science, Bioimaging and Artificial Intelligence for disease diagnosis.

| Total Lecture Hours | 75 hours |
|---|---|

**Textbook:**
1. G. K. Suraishkumar, Oxford University Press.
2. C.V Raman rao , I.K International press

3. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.

**Reference Books:**

1. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press,2008.
2. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

| Course Code: EC212E | Course Name: Digital Integrated Circuit Design | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**Pre-requisite:** NA

**Course Objectives:**

1. To understand the RTL-to-GDSII digital design flow.
2. To learn the fundamentals of Static Timing Analysis (STA), covering timing paths, setup/hold times, and timing constraints.
3. To provide hands-on exposure to STA tools, functional verification techniques, and power analysis.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand the digital design flow, including RTL-to-GDSII.
2. Design and implement RTL models using Verilog, and apply synthesis optimizations.
3. Perform Static Timing Analysis (STA) by understanding timing parameters and constraints.
4. Apply functional verification methods and use EDA tools for equivalence checking.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 1 | | | - | - | - | - | 2 |
| CO2 | 2 | 2 | 2 | 3 | 3 | | | - | - | - | - | 2 |
| CO3 | 2 | 2 | 3 | 2 | 2 | - | - | - | - | - | - | 2 |
| CO4 | 2 | 2 | 3 | 2 | 3 | - | - | - | - | - | - | 2 |

| Unit 1 | Fundamentals of Digital Design Flow and HDL | 15 hours |
|---|---|---|

Introduction to ASIC and FPGA Design Flow: RTL-to-GDSII flow, Basics of Hardware Description Languages (HDLs): Verilog vs. VHDL, Verilog design flow and simulation basics, Module definition, ports, and data types, Modeling styles: Gate-level modeling Dataflow modeling, Behavioral modeling.

| Unit 2 | Verilog Programming | 15 hours |
|---|---|---|

Verilog Operators, expressions, and procedural assignments, Verilog code for basic combinational logic circuits (e.g., adder, multiplexer, encoder) and sequential circuit (e.g. Flip flops, counter, register, FSM).

| Unit 3 | Introduction to Logic Synthesis | 15 hours |
|---|---|---|

Definition and purpose of synthesis, Technology-independent vs. technology-dependent optimizations, Synthesis tools overview.

| Unit 4 | Static Timing Analysis (STA) Basics and Timing Paths | 15 hours |
|---|---|---|

Fundamentals of Timing Analysis: Setup time, hold time, propagation delay, Clock period, clock skew, and clock jitter. Types of Timing Paths in a Digital Circuit: Data path, clock path, asynchronous paths, Critical path analysis, Timing Models and STA Basics: Transition time, cell delay, net delay, Wire-load models, parasitic extraction.

| Unit 5 | Introduction to Functional Verification | 15 hours |
|---|---|---|

Concept of Functional Verification, Pre & Post Synthesis Analysis. Introduction to Power Analysis.

| | Total Lecture Hours | 75 hours |
|---|---|---|

**Textbook:**

1. Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication, Hubert Kaeslin, Cambridge University Press, 2008.
2. Verilog HDL: A Guide to Digital Design and Synthesis, Samir Palnitkar, Pearson, 2nd Edition, 2003.

**Reference Books:**

1. Introduction to VLSI Design Flow, Sneh Saurabh, Cambridge University Press 2023.

2. Charles Roth & Lizy Kurian John – Digital Systems Design Using Verilog, Cengage
3. Michael D. Ciletti – Advanced Digital Design with the Verilog HDL, Pearson
4. Stephen Brown and Zvonko Vranesic – Fundamentals of Digital Logic with Verilog Design, McGraw Hill.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

| Course Code: EE205E | Course Name: Modelling Dynamic Systems and Physical Components using MATLAB | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**Pre-requisite:** NA

**Course Objectives:** Aim to equip the students with the skills to model, simulate, and analyze dynamic physical systems using MATLAB and Simulink, with a focus on real-world vehicle applications.

**Course Outcome:** After completion of the course, the student will be able to

1. Explain the fundamentals and classification of dynamic systems and models.
2. Apply MATLAB programming and plotting techniques to simulate basic dynamic systems.
3. Develop dynamic system models using bond graphs and simulate using Simulink.
4. Design and simulate vehicle subsystems such as engine, drivetrain, and braking.
5. Interpret simulation data and evaluate the behavior of vehicle dynamic systems.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | - | - | 2 | 2 | 2 | - | - | - | - | 2 |
| CO2 | 2 | - | 2 | - | 2 | 2 | 2 | - | 2 | - | - | 2 |
| CO3 | 3 | - | 3 | 2 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| CO5 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |

**Unit 1 | Fundamentals of Dynamic System and Modelling | 15 hours**

Introduction to dynamic systems and need for modeling, Classification of Models- Scaled physical model, Mathematical model, Case study of passenger vehicle suspension system depicting model theories, Principles used in Modelling, Modeling of Dynamic systems, Transfer Function Models and State-space model, First and Second order, Need for Simulation.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Modeling and Simulation of a DC Motor Using State-Space Representation
- Simulink-Based Simulation of Dynamic Systems for Input Disturbance Analysis
- Simulation of a Quarter Car Suspension System Using Transfer Function Approach

**Unit 2 | MATLAB as a Simulation Tool | 15 hours**

Comparison of Analytical and Simulation methods, Types of Simulation – Continuous and Discrete Event, MATLAB as simulation tool, Demonstration of MATLAB Environment- Basics of MATLAB Programming and execution, Function statements and Plotting, Example- Modeling of Power window actuation system, solving equation using MATLAB, Introduction to Simulink – Blocks introduction, Mass-Spring-Damper system solving in MATLAB

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Analytical vs. Simulation-Based Response of a Mass-Spring-Damper System Using MATLAB
- Introduction to MATLAB Programming: Solving Differential Equations and Plotting System Response

**Unit 3 | Bond Graphs and Modeling systems in MATLAB | 15 hours**

Bond Graph- Requirement, Advantages and Power Variables, Causality, Basic System Elements- electrical, mechanical and thermal, Simulation of models using Simulink, Sources→systems→sinks, building a Simulink model, simulation parameters, modifying subsystems parameters, simulation output.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Modeling and Simulation of an Electro-Mechanical System Using Bond Graphs and Simulink
- Parameter Modification and Output Analysis of Bond Graph-Based Dynamic Models in Simulink

**Unit 4 | Modeling and Simulation of Vehicle Subsystems Using Simulink | 15 hours**

Vehicle Dynamics overview- Lateral and Longitudinal dynamics, vehicle as a multi-body dynamic system, modeling

longitudinal vehicle dynamics, Simulink model for vehicle acceleration/deceleration including acting forces, Vehicle subsystem to simulate- Braking system model, Engine and drivetrain system model using Simulink.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Simulation of Engine and Drivetrain Subsystem Dynamics in a Vehicle Using Simulink
- Braking System Simulation: Force Analysis and Vehicle Response Using Simulink
- Vehicle as a Multi-Body Dynamic System: Integrated Subsystem Modeling in Simulink

| **Unit 5** | **Interpretation of Results** | **15 hours** |
|---|---|---|

Interpreting the results derived of various Vehicle Models simulated using Simulink, Data Logging and Analysis, Hands on Experience, Results Presentation

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Data Logging and Performance Analysis of Vehicle Acceleration and Braking in Simulink
- Real-Time Data Monitoring and Logging for a Vehicle Suspension System in Simulink

| | **Total Lecture Hours** | **75 hours** |
|---|---|---|

**Textbook:**

1. W. J. Palm III, System Dynamics. New York, NY, USA: McGraw-Hill, 2005
2. D. C. Karnopp, D. L. Margolis, and R. C. Rosenberg, System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems, 5th ed. Hoboken, NJ, USA: Wiley, 2012.

**Reference Books:**

1. W. J. Palm III, System Dynamics. New York, NY, USA: McGraw-Hill, 2005.
2. Tewari, Modern Control Design with MATLAB and Simulink. Hoboken, NJ, USA: Wiley, 2007.
3. K. Ogata, Modern Control Engineering, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2009.
4. H. Klee and R. Allen, Simulation of Dynamic Systems with MATLAB and Simulink, 2nd ed. Boca Raton, FL, USA: CRC Press, 2011.

**Mode of Evaluation:**

| **MSE** | | **CA** | | | **ESE** | **Total** |
|---|---|---|---|---|---|---|
| **MSE1** | **MSE2** | **CA1** | **CA2** | **CA3(ATT)** | | |
| 40 | 40 | 8 | 8 | 4 | **100** | **200** |
| **80** | | **20** | | | | |

| **Course Code: EE207E** | **Course Name: Sensors & Automation Essentials** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **2** | **4** |

**Pre-requisite:** NA

**Course Objectives:** Aim to give exposure to the students about Sensors & Automation which are required in industry.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand the PLC, Communication protocol role in industrial automation and role of IIOT gateways.
2. Understand the PLC panel electrical wiring on PLC Analog and digital cards.
3. Apply the Role of industrial gateways in IIOT.
4. Develop the real time application covering of IIOT.
5. Establish Communication between two industrial devices.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| **CO-PO Mapping** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | - | - | - | 2 | 2 | 2 | - | - | - | - | 2 |
| **CO2** | 2 | - | 2 | - | 2 | 2 | 2 | - | 2 | - | - | 2 |
| **CO3** | 3 | - | 3 | 2 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| **CO5** | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |

| **Unit 1** | **Introduction Industrial Automation & IIOT** | **15 hours** |
|---|---|---|

Types of Industrial Automation Factory & Process automation, Hierarchy involved Field to operating level, Internal structure of PLC (Internal electronics) and their IP ratings, Selection criteria of PLC, Communication protocol role in industrial automation, Role of IIOT gateways, PLC programming Languages, data types in PLC (real time application based Digital number system), practical application based on digital logic gates.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Study and Simulation of Industrial Automation Hierarchies: From Field Devices to Control Rooms
- Digital Logic Gate Implementation and Real-Time PLC Programming Using Ladder Logic

| Unit 2 | Digital & Analog signal types in PLC | 15 hours |
|---|---|---|

Pheonix PLC panel electrical wiring on PLC Analog and digital cards, covering how digital & analog signal processing with analog signal scaling with real time application (covering temperature & pressure transmitter). CAD and SLD drawing reading as per application.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Wiring and Testing of Phoenix PLC Digital and Analog I/O Cards for Real-Time Applications
- Analog Signal Conditioning and Processing: Interfacing with Phoenix PLC Analog Cards

| Unit 3 | Communication protocols in IIOT | 15 hours |
|---|---|---|

Role of industrial gateways in IIOT, discussing key protocols Modbus TCP-IP, RS-232, RS-485, Profinet Profibus, and web data sharing protocols like MQTT etc.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Experimenting with Modbus TCP/IP Communication via Industrial Gateways
- RS-485 to MQTT Data Transmission: A Hands-On Approach
- Integrating Profibus and Profinet Networks Using Industrial Gateways
- Cloud Data Sharing via MQTT: Real-Time Monitoring in IIoT
- RS-232 to Cloud Integration: Leveraging Industrial Gateways for IIoT

| Unit 4 | Sensor & Instrumentation Interfacing with PLC | 15 hours |
|---|---|---|

Sensor & Instrumentation Interfacing with PLCs, Sensor Signal Conditioning and Interfacing Techniques (Interfacing techniques (sink/source wiring, voltage/current input, relay outputs), Real-world applications: motor control, process automation.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Sensor and Instrumentation Interfacing with PLCs in Industrial Automation
- Signal Conditioning Techniques for Sensor Integration with PLCs
- Understanding Sink/Source Wiring and Voltage/Current Input in PLC Systems
- Motor Control Applications Using PLCs in Industrial Automation
- Real-World Process Automation: PLC-Based Control of Temperature, Pressure, and Flow

| Unit 5 | Application Development | 15 hours |
|---|---|---|

Developing real time application covering all above topics (like analog digital processing with analog signal scaling), Establishing communication between two industrial devices.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Developing a Real-Time PLC Application for Analog and Digital Signal Processing
- Establishing Communication Between Industrial Devices: A Real-Time PLC-Based System
- Analog Signal Scaling and Digital Processing in Real-Time Industrial Applications
- Designing a Real-Time Motor Control System Using PLCs and Sensor Integration
- Building a Real-Time Process Automation System with PLC Communication and Signal Conditioning

**Total Lecture Hours** **75 hours**

**Textbook:**

1. V. Kumar, *Getting Started with S7-1200*. Siemens Automation, 2017.

**Reference Books:**

1. J. W. Webb and R. A. Reis, *Programmable Logic Controllers: Principles and Applications*, 5th ed. Upper Saddle River, NJ, USA: Prentice Hall, 2002.
2. R. Singh, *SCADA for Engineers*, New Delhi, India: KHANNA Publishing, 2016.
3. R. Srinivasan, *PLC and SCADA for Beginners*, Chennai, India: Technical Publications, 2020.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

| Course Code: EL202L | Course Name: Control Engineering | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Basic Electrical Engineering, Differential Equations, Linear Algebra, Signals & Systems

**Course Objectives:**

1. To introduce fundamental principles of control systems, mathematical modeling and computational analysis.
2. To analyze system stability using time-domain and frequency-domain techniques.
3. To analyze the use of compensators in time-domain and frequency-domain.

**Course Outcome:** After completion of the course, the student will be able to

1. Explain open-loop and closed-loop systems, and apply mathematical modeling techniques.

2. Analyze the performance of basic control systems in the time domain.
3. Analyze the stability of linear time-invariant systems in time domain using Routh Hurwitz criterion and root locus technique.
4. Analyze the stability of linear time-invariant systems in frequency domain using Nyquist criterion and Bode plot.
5. Understand the different types of compensators to achieve the desired performance of control System.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | - | - | - | - | - | - | - | 1 | - | 3 |
| CO2 | 3 | 2 | - | 2 | 2 | - | - | - | - | 1 | - | 3 |
| CO3 | 3 | 2 | - | 2 | 3 | - | - | - | - | 1 | - | 3 |
| CO4 | 3 | 2 | - | 2 | 3 | - | - | - | - | 1 | - | 3 |
| CO5 | 3 | 1 | - | 1 | 2 | - | - | - | - | 1 | | 2 |

| **Unit 1** | **Introduction to Control System** | **09 hours** |
|---|---|---|

Basics of Control Systems, Open-loop vs Closed-loop Control, Transfer function, Determination of transfer function using block reduction technique and signal flow graph (SFG) approach, Mathematical Modeling of Systems using Differential and Transfer Function Equations, MATLAB/Python for system modeling.

| **Unit 2** | **Time Response Analysis** | **09 hours** |
|---|---|---|

Standard test signals, time response analysis of first and second order systems, time response specifications of second order system for unit step input, location of roots of characteristics equation and corresponding time response, steady state errors and error constants, step response analysis using MATLAB/Python.

| **Unit 3** | **Stability Analysis in Time Domain** | **09 hours** |
|---|---|---|

Concept of stability and its necessary conditions, Routh-Hurwitz criteria, and its limitations, Salient features of root locus plot, Procedure for plotting root locus, examples based on root locus, PID controllers, Tuning using Ziegler-Nichols, MATLAB implementation for stability analysis in time domain.

| **Unit 4** | **Stability Analysis in Frequency Domain** | **09 hours** |
|---|---|---|

Frequency Response analysis from transfer function model, Correlation between time and Frequency Responses, Construction of polar plot, Bode Plot, Nyquist stability criterion, Mapping theorem, Determination of gain and phase margin from Bode & Nyquist Plots. MATLAB implementation for stability analysis in frequency domain.

| **Unit 5** | **Compensation Techniques and State Space Analysis** | **09 hours** |
|---|---|---|

Introduction to Design: The design problems and preliminary considerations of lead, lag and lead-lag compensation networks, design of compensation networks using time response and frequency response of the system. Introduction to FPGA-based control systems.

State Space Technique: The concept of state & space, State-space model of physical system, conversion of state-space to transfer function model and vice-versa, State transition matrix, Concept of controllability and observability and their testing.

| | **Total Lecture Hours** | **45 hours** |
|---|---|---|

**Textbook:**

1. Katsuhiko Ogata, Modern Control Engineering, Pearson.
2. Benjamin C. Kuo, Automatic Control Systems, Wiley.
3. Gopal M, Control Systems: Principles and Design, McGraw Hill.
4. Norman S. Nise, Control Systems Engineering, Wiley.
5. B.S. Manke, “Linear Control Systems”, Khanna Publishers.

**Reference Books:**

1. Franklin, Powell & Emami-Naeini, Feedback Control of Dynamic Systems, Pearson.
2. B. Wayne Bequette, Process Control: Modeling, Design & Simulation, Prentice Hall.
3. Astrom & Murray, Feedback Systems: An Introduction for Scientists and Engineers, Princeton University Press.
4. S. Hasan Saeed, “Control Systems”, S. K. Kataria & Sons.
5. Ashfaq Husain, Haroon Ashfaq, “Control Systems”, Dhanpat Rai & Co.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 30 | 30 | 6 | 6 | 3 | 75 | 150 |
| 60 | | 15 | | | | |

| Course Code: EL203L | Course Name: Electrical Power Systems | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite:** Basic Electrical Engineering, Circuit Theory and Basics of Electric and Magnetic Fields

**Course Objectives:**

1. To build foundational knowledge of power generation, transmission, and system design for practical power system applications.
2. To develop analytical skills in transmission line design, fault analysis, and load flow, essential for power system operation and protection careers.
3. To prepare students for industry roles in utilities, grid operations, and power consultancy by understanding system stability and transients

**Course Outcome:** After completion of the course, the student will be able to

1. Understand power system structure and power generation methods.
2. Calculate transmission line parameters and assess associated effects.
3. Evaluate transmission line performance and compute losses.
4. Analyze symmetrical and unsymmetrical faults in power systems.
5. Understand power system transients and stability improvement techniques.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | - | - |
| CO2 | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - |
| CO3 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - |
| CO4 | 3 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - |
| CO5 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - |

| **Unit 1** | **Fundamentals of Power Systems** | **08 hours** |
|---|---|---|

Basic structure of power system, Types of conductors, Ampere's law and inductance of transmission lines, Inductance of single-phase and three-phase lines, Bundled conductors, Capacitance of overhead lines (single and three-phase), Effect of earth on capacitance.

| **Unit 2** | **Transmission Line Parameters and Effects** | **08 hours** |
|---|---|---|

Classification of transmission lines (short, medium, and long), General performance equations (ABCD constants), Corona phenomenon and factors affecting it, Critical disruptive voltage, Ferranti Effect (with MATLAB visualization), Skin Effect and Proximity Effect, Voltage regulation and efficiency.

| **Unit 3** | **Fault Analysis** | **09 hours** |
|---|---|---|

Per Unit System and Its Significance, Introduction to Power System Faults (Types and Characteristics), Symmetrical Fault Analysis using Thevenin's Equivalent, Symmetrical Components and Sequence Networks, Unsymmetrical Fault Analysis (LG, LL, LLG faults), Effects of Faults and Protection Considerations

| **Unit 4** | **Power System Transients and Stability** | **10 hours** |
|---|---|---|

Types of stability, swing equation, point by point method, Equal area criterion for stability, Rotor angle dynamics and swing equation, Methods to improve system stability.

| **Unit 5** | **Power Flow Studies** | **10 hours** |
|---|---|---|

Mathematical model of power flow studies, Solution techniques: Gauss-Seidel method, Newton Raphson method, fast decoupled load flow method, comparison of solution technique. MATLAB code for basic Gauss-Seidel load flow for 3-bus system.

| | **Total Lecture Hours** | **45 hours** |
|---|---|---|

**Textbook:**

1. J. Duncan Glover, Thomas Overbye, and Mulukutla S. Sarma, Cengage
2. C.L. Wadhwa, Electrical Power Systems, New Age International Publishers
3. D.P. Kothari & I.J. Nagrath, Power System Engineering, McGraw Hill
4. Hadi Saadat, Power System Analysis, Tata McGraw Hill

**Reference Books:**

1. O.I. Elgerd, Electric Energy Systems Theory: An Introduction, McGraw-Hill
2. J. Grainger and W.D. Stevenson, Power System Analysis, McGraw-Hill
3. P.S.R. Murthy, Power System Operation and Control, BS Publications
4. B.R. Gupta, Power System Analysis and Design, S. Chand & Co.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 30 | 30 | 6 | 6 | 3 | 75 | 150 |
| 60 | | 15 | | | | |

| Course Code: HS112L | Course Name: Universal Human Values | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisite: NA**

**Course Objectives:**

1. To help students distinguish between values and skills, and understand the need, basic guidelines, content, and process of value education.
2. To help students initiate a process of dialog within themselves to know what they really want to be in their life and profession
3. To help students understand the meaning of happiness and prosperity for a human being.
4. To facilitate the students to understand harmony at all the levels of human living, and live accordingly.
5. To facilitate the students in applying the understanding of harmony in existence in their profession and lead an ethical life.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content, and process of value education, explore the meaning of happiness and prosperity, and do a correct appraisal of the current scenario in the society.
2. Distinguish between the Self and the Body, and understand the meaning of Harmony in the Self and the Co-existence of Self and Body.
3. Understand the value of harmonious relationships based on trust, respect, and other naturally acceptable feelings in human-human relationships and explore their role in ensuring a harmonious society.
4. Understand the harmony in nature and existence, and workout their mutually fulfilling participation in nature.
5. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | 2 | 2 | 2 | 1 | - | 1 | 1 |
| CO2 | - | - | - | - | - | 2 | 2 | 2 | 1 | - | 1 | 1 |
| CO3 | - | - | - | - | - | 2 | 2 | 2 | 1 | - | 1 | 1 |
| CO4 | - | - | - | - | - | 2 | 2 | 2 | 1 | - | 1 | 1 |
| CO5 | - | - | - | - | - | 2 | 2 | 3 | 1 | - | 1 | 1 |

| Unit 1 | Introduction to Value Education | 10 hours |
|---|---|---|

Understanding the need, basic guidelines, content, and process for Value Education, Self- Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation –as the mechanism for self-exploration, Continuous Happiness, and Prosperity-A look at basic Human Aspirations, Right understanding, Relationship, and Physical Facilities-the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly – A critical appraisal of the current scenario, Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

| Unit 2 | Understanding Harmony in the Human Being | 10 hours |
|---|---|---|

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha, Understanding the Body as an instrument of 'I' (I being the doer, seer, and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, the meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

| Unit 3 | Understanding Harmony in the Family and Society | 10 hours |
|---|---|---|

Harmony in Human-Human Relationship Understanding harmony in the Family-the basic unit of human interaction, Understanding values in the human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect(Samman) as the foundational values of relationship, Understanding the meaning of Vishwas; Difference between intention and competence, Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in a relationship, Understanding the harmony in the society (society being an extension of the family): Samadhan, Samridhi, Abhay, Sah- astitva as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha) – from family to world family!

| Unit 4 | Understanding Harmony in Nature and Existence | 09 hours |
|---|---|---|

Whole existence as Co-existence Understanding the harmony in Nature, Inter connectedness, and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature, Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

| Unit 5 | Implications of the above Holistic Understanding of Harmony on Professional Ethics | 06 hours |
|---|---|---|

Natural acceptance of human values, Definiteness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in Professional Ethics.

**Total Lecture Hours** | **45 hours**

**Textbook:**

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.

**Reference Books:**

1. Ivan Illich, Energy & Equity, The Trinity Press, Worcester and Harper Collins, USA,1974.
2. E.F. Schumacher, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain,1973.
3. A Nagraj, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak 1998.
4. P L Dhar, RR Gaur, Science and Humanism, Commonwealth Publishers 1990.

**Mode of Evaluation**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3 (ATT) | | |
| 30 | 30 | 6 | 6 | 3 | | |
| 60 | | 15 | | | 75 | 150 |

| Course Code: HS113L | Course Name: Aptitude-2 | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | 1 |

**Pre-requisite: NA**

**Course Objectives:**

1. To provide adequate exposure to the students regarding the use of aptitude tests in the recruitment process and competitive examinations.
2. To improve the logical & numerical ability of the students.

**Course Outcome:** After completion of the course, the student will be able to

1. Illustrate their comprehension by solving the given problems
2. Apply the learned concepts to new problems and solve them aptly.
3. Make use of their thought process to interpret and draw inferences from the given data to reach logical conclusions.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | 1 | - | 1 | - | - | - | - | - | 1 |
| CO2 | 1 | 1 | - | 1 | - | 2 | - | - | - | - | - | 1 |
| CO3 | 1 | 1 | - | 1 | - | 1 | - | - | - | - | - | 2 |

**Unit 1** | **Analytical Reasoning & Logical Puzzles** | **04 hours**

Definition and Introduction of Concept and Relation of Cube and Cuboids, Cut the cube in different layer and then solve questions accordingly. Problems related with open and closed dice.

**Unit 2** | **Syllogism** | **03 hours**

Understanding of Venn diagram, Problems related with Venn diagram, Statement and Conclusion, Syllogism and reverse syllogism.

**Unit 3** | **Clock and Calendar** | **04 hours**

Definition and Introduction of Concept and Relation of angle and time, Overtaking, overlapping, right-angle and straight Angle with respect to time, Error in clock (faster and slower), Correct time of clock, Mirror and Water Image of clock, Introduction of Calendar, Concept of Normal and Leap Year, Finding Odd days, Finding the day of the week of given date with and without reference.

**Unit 4** | **Data Interpretation and Critical Reasoning** | **04 hours**

**Tables** (Understand of Table, Fillers in table), **Line Graph** (Understand the graph, Percentage change, Ratio based comparison), **Bar Graph** (Type of Bar Graph, Average and Comparison, Stacked Bar Graph), **Pi Chart** (Conversion of Percentage and Degree, Fillers in Pie chart, Multiple Pie chart), **Mixed Graph (problems** related with combination of various charts**) Critical Reasoning**: Assumptions, Cause and Effect, Assertion and Reason, Statement and Inference

**Total Lecture Hours** | **15 hours**

**Useful resources:**

1. **"**A Modern Approach to Verbal & Non-Verbal Reasoning" by R.S. Aggarwal, S. Chand Publication.
2. https://www.geeksforgeeks.org/most-important-aptitude-topics-for-placements/

**Reference Books:**

1. "How to Prepare for Logical Reasoning for the CAT" by Arun Sharma, TMH Publication.
2. https://www.indiabix.com/logical-reasoning/questions-and-answers/
3. https://testbook.com/placement-aptitude/test-series

| Mode of Evaluation | | | | | | |
|---|---|---|---|---|---|---|
| MSE | | CA | | | ESE | Total |
| MSE1 | MSE2 | CA1 | CA2 | CA3 (ATT) | | |
| - | - | 10 | 10 | 5 | | |
| - | | 25 | | | 25 | 50 |

| Course Code: HS114L | Course Name: Soft Skills Essentials 2 | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | NC |

**Pre-requisite:**

- Successful completion of the subject 'Soft Skills Essentials-1' of the third semester.

**Course Objectives:**

To strengthen students' professional communication, cultural intelligence, and emotional awareness through advanced speaking activities, scenario-based discussions, and digital literacy tasks, equipping them for diverse workplace interactions.

**Course Outcome:** After completion of the course, the student will be able to

1. Apply advanced communication strategies that include vocabulary enhancement, storytelling to improve their cultural sensitivity (DEI).
2. Demonstrate prompt writing for AI-based tools and create effective elevator pitches to convey ideas with clarity and impact.
3. Exhibit interpersonal effectiveness by navigating negotiation, persuasion, and emotional intelligence in professional contexts

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | 1 | - | - | 1 | 3 | - | 2 |
| CO2 | - | - | - | - | - | - | - | - | 1 | 3 | - | 2 |
| CO3 | - | - | - | - | - | 1 | - | - | 1 | 3 | - | 2 |

| Unit 1 | Advanced Communication and Cultural Sensitivity | 7 hours |
|---|---|---|

Vocabulary Enhancement through Gamification, Story Coining and Presentations Understanding Cross-Cultural, Communication (DEI) using Case Studies, Duo Lingo English Proficiency Tests

| Unit 2 | Professional Expression and Digital Literacy | 4 hours |
|---|---|---|

TMAY through Driver's test, Writing Effective Prompts on Various LLMs, Duo Lingo English Proficiency Tests

| Unit 3 | Interpersonal Effectiveness and Emotional Intelligence | 4 hours |
|---|---|---|

Negotiation & Persuasion Role Plays, Developing Emotional Intelligence via Scenario-Based Discussions

| Total Lecture Hours | 15 hours |
|---|---|

**Useful Resources:**

1. https://youtu.be/5Wr-uaGzY7c
2. https://youtu.be/NcCwlqBapHo
3. https://youtu.be/SKNmQPIBPIg
4. RAISEC - B. Tech. MCA - Introduction
5. RAISEC - B. Tech. MCA - Social Personality Type
6. RAISEC - B. Tech. MCA - Enterprising Personality Type
7. RAISEC - B. Tech. MCA - Conventional Personality Type

**Mode of Evaluation**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3 | | |
| - | - | 10 | 10 | 5 | | |
| - | | 25 | | | 25 | - |

| Course Code: IT202B | Course Name: Data Analytics | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**Pre-requisite:** Basic Knowledge of Python

**Course Objectives:**

1. The objective of this course is to introduce key concepts, lifecycle, and tools in data analytics.
2. The aim is to build practical skills in data preprocessing, visualization, and machine learning techniques.
3. The course also focuses on exploring big data technologies such as Hadoop and Spark.

**Course Outcome:** After completion of the course, the student will be able to

1. Explain key concepts, tools, and applications of data analytics.
2. Apply data cleaning and preprocessing using Python libraries.
3. Analyze data and visualize insights with BI tools.
4. Implement ML algorithms for classification and clustering.
5. Explore Big data framework and demonstrate Hadoop processing.

**CO-PO Mapping (Scale1:Low, 2:Medium, 3:High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | 1 |
| CO2 | 2 | 3 | 3 | 2 | 2 | - | - | - | - | - | 1 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 3 | 1 | - | - | - | - | 1 | 2 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 1 | - | - | - | - | 1 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 2 | 1 | - | - | 2 | - | 1 | 2 |

| **Unit 1:** | **Introduction to Data Analytics** | **10 hours** |
|---|---|---|

Data and types of data (structured, unstructured, semi-structured), characteristics of data, need of data analytics, data analytic tools, applications of data analytics, Data Analytics Lifecycle (DALC), key roles for successful analytic projects.

| **Unit 2** | **Data Collection, Cleaning & Preprocessing** | **12 hours** |
|---|---|---|

Sources (Primary and Secondary), handling missing data, outliers, noise, transformation, normalization and data wrangling using libraries like Pandas and NumPy.

| **Unit 3** | **Exploratory Data analysis & Visualization:** | **14 hours** |
|---|---|---|

**Statistics and Probability for Data Analysis:**
Distributions, mean, standard deviation, median, and mode, Statistics that are inferred: Confidence intervals, regression analysis, and hypothesis testing, Ideas in Probability: Random variables, probability distributions, and the Bayes Theorem.
**Data Visualization Tools:**
Overview of Power BI & Tableau: Generating dynamic reports and dashboards. Interactive Case Studies: Using visualization approaches to solve practical business issues.

| **Unit 4** | **Machine learning for Data Analytics:** | **12 hours** |
|---|---|---|

Introduction to supervised learning and unsupervised learning, Classification models: Decision Trees, k-NN, Naive Bayes, Clustering algorithms: K-Means, Hierarchical Clustering, Dimensionality reduction: PCA, Association rule mining (Apriori algorithm), Model evaluation: Confusion Matrix, Accuracy, Precision, Recall, F1-Score.

| **Unit5** | **Big Data and Advanced Analytics:** | **12 hours** |
|---|---|---|

Introduction to Big Data, Characteristics of Big data, Big data challenges, Example of big data in real life, Hadoop, Hadoop components, Hadoop ecosystem, Overview of Apache Spark, Pig, Hive, Hbase and Sqoop, Map reduce paradigm: algorithm MapReduce, Matrix vector multiplication by MapReduce.

| | **Total Lecture Hours** | **60 hours** |
|---|---|---|

**Text books**
1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press.
3. John Garrett,Data Analytics for IT Networks : Developing Innovative Use Cases, Pearson Education

**Reference Books:**
1. Foster Provost, Tom Fawcett, Data Science for Business, O'Reilly Media.
2. Wes McKinney, Python for Data Analysis, O'Reilly Media.
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning, Springer.
4. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, Morgan Kaufmann.
5. Nathan Marz, James Warren, Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Manning Publications.

**Mode of Evaluation**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1<br>30 | MSE2<br>30 | CA1<br>6 | CA2<br>6 | CA3(ATT)<br>3 | | |
| 60 | | 15 | | | 75 | 150 |

| **Course Code: EL204B** | **Course Name: Object-Oriented Programming using C++** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **2** | **0** | **2** | **3** |

**Pre-requisite:** NA

**Course Objectives:**
1. Introduce object-oriented programming concepts and their implementation in C++
2. Develop real-world applications using OOP, memory management, file handling, and STL

**Course Outcome:** After completion of the course, the student will be able to

1. Understand and apply Object-Oriented Programming concepts using C++
2. Develop C++ programs using classes, objects, constructors, destructors, and memory management techniques
3. Implement inheritance and polymorphism mechanisms in C++
4. Apply file handling and exception handling concepts in solving problems
5. Demonstrate usage of STL (Standard Template Library) and develop small projects integrating OOP principles

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | - | 2 | - | - | - | - | 2 | - | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 2 | - | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | - | 2 | - | - | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 2 | 2 | 2 |

| Unit 1 | Introduction to OOP and C++ Basics | 12 hours |
|---|---|---|

**Introduction to Programming Paradigms**: - Programming Paradigms: Procedural vs OOP, OOP Concepts: Encapsulation, Abstraction, Inheritance, Polymorphism, Basic C++ Structure, Data types, Operators, Functions, Default Arguments.

**Problem Solving:**

- Write a C++ program to demonstrate input/output, use of basic data types, and arithmetic operations.
- Create an overloaded function named area() to calculate the area of a circle, rectangle, and triangle.
- Write a program using a function with default arguments to calculate the power of a number.
- Define a class Student that demonstrates encapsulation by using private data members and public member functions.
- Implement the salary calculation for employees using both procedural programming and OOP approach. Compare the two styles.

| Unit 2 | Classes, Objects, Constructors, and Memory Management | 12 hours |
|---|---|---|

Defining Classes and Objects, Constructors: Default, Parameterized, Copy, Destructors, Static members, Dynamic Memory (new, delete)

**Problem Solving:**

- Write a program to define a class Book that demonstrates default, parameterized, and copy constructors.
- Create a program that shows how destructors work when multiple objects go out of scope.
- Write a C++ program to demonstrate the use of static data members and static member functions in a class.
- Implement a class Product and dynamically allocate and deallocate an array of Product objects using new and delete.

| Unit 3 | Inheritance and Polymorphism | 12 hours |
|---|---|---|

Single Inheritance, Function Overriding, Runtime Polymorphism (Virtual Functions).

**Problem Solving:**

- Create a class Person and derive a class Employee from it. Demonstrate single inheritance by initializing both classes and displaying data.
- Write a program to implement multilevel inheritance: Class University → Department → Student.
- Demonstrate function overriding using a base class and a derived class both having a display() function.
- Write a program to demonstrate runtime polymorphism using virtual functions for shape classes like Circle and Rectangle.
- Overload the + operator to add two complex numbers using operator overloading in C++.

| Unit 4 | File Handling and Exception Handling | 12 hours |
|---|---|---|

Basic File Operations (open, read, write), Exception Handling Basics (try, catch, throw).

**Problem Solving:**

- Write a C++ program to **store and read** student records from a **text file** using file handling.
- Implement a program that **appends data** to an existing file without overwriting previous content.
- Create a program to divide two numbers and use **try-catch** to handle **divide-by-zero** exception.
- Define a **custom exception class** for invalid age input and demonstrate throwing and catching that exception.

| Unit 5 | Standard Template Library (STL) and OOP Mini Project | 12 hours |
|---|---|---|

Introduction to STL: Components – Containers, Algorithms, Iterators, Vector, List, Deque, Set, Map, Unordered Set, Stack, Queue, STL Algorithm: Sorting and Searching.

**Problem Solving:**

- Write a C++ program using vector to store a list of integers, then sort and display them.
- Use a list to store employee names. Demonstrate insertion at front, back, and deletion from the list.
- Use a map to store and retrieve student names using their roll number as keys.

| Total Lecture Hours | 60 hours |
|---|---|

**Textbook:**

1. James Rumbaugh et. al, "Object Oriented Modeling and Design", PHI
2. Grady Booch, James Rumbaugh, Ivar Jacobson, "The Unified Modeling Language User Guide", Pearson Education
3. Object Oriented Programming with C++, E Balagurusamy, TMH

**Reference Books:**

1. R. S. Salaria, Mastering Object Oriented Programming with C++, Khanna Publishing House
2. C++ Programming, Black Book, Steven Holzner, dreamtech
3. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia
4. Object Oriented Programming with ANSI and Turbo C++, Ashok Kamthane, Pearson
5. The Compete Reference C++, Herbert Schlitz, TMH

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 30 | 30 | 6 | 6 | 3 | 75 | 150 |
| 60 | | 15 | | | | |

| Course Code: EL205B | Course Name: Database Management and Operating Systems for Engineers | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**Pre-requisite:** NA

**Course Objectives:**

1. To introduce fundamental concepts of Database Management Systems (DBMS) and Operating Systems (OS) for efficient data management and system operations.
2. To apply process management, memory management, and SQL concepts in real-world applications, including Smart Grid Systems.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand DBMS and OS fundamentals and apply ER modeling to design databases.
2. Apply normalization and transaction management techniques for data consistency.
3. Analyze process scheduling and deadlock handling in Operating Systems.
4. Evaluate memory management techniques and virtual memory for real-time processing.
5. Understand the various operating system and their algorithm.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | - | 2 | - | - | - | - | 2 | - | 2 |
| CO2 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | 2 | - | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | - | 2 | - | - | 2 | 2 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | 2 | 2 | 2 |

| Unit 1 | Fundamentals of DBMS and SQL | 15 hours |
|---|---|---|

Data vs Information, File System vs DBMS, Data Models, E-R Modeling (Entities, Attributes, Relationships, Cardinality, Aggregation, Generalization), SQL Basics: Data types, Constraints, SQL Commands, Joins (Inner, Left, Right, Full), Aggregate Functions, Views, Real-World Application.

**Problem solving:**

- Create ER diagram for Smart Grid Database System.
- Create tables Customer, Meter, Usage with Constraints: Primary Key, Foreign Key, CHECK, DEFAULT in SQL.
- Use INNER, LEFT, RIGHT, FULL joins to fetch usage details per customer

| Unit 2 | Normalization and Transaction Management | 15 hours |
|---|---|---|

Need for Normalization, Functional Dependencies, 1NF, 2NF, 3NF, BCNF, Introduction to Transactions, ACID Properties, Scheduling and Serializability: Conflict & View Serializable, Concurrency Control: Basic 2PL, Timestamp

Ordering.

**Problem solving:**

- Create a VIEW called High Usage Customers (if usage > 500)
- Write a TRIGGER on Billing to ensure Bill Amount > 0.

| **Unit 3** | **Process Management and Deadlocks in OS** | **10 hours** |
|---|---|---|

Program vs Process, PCB, Process States, CPU Scheduling Algorithms: FCFS, SJF, Priority Scheduling, Round Robin, Multilevel Queue, Deadlocks: Definition, Conditions, Prevention.

**Problem Solving:**

- Write a program in C to implement the First Come First Serve (FCFS) scheduling algorithm.
- Write a program in C to simulate non-preemptive Shortest Job First (SJF) CPU scheduling.

| **Unit 4** | **Memory and Storage Management in OS** | **10 hours** |
|---|---|---|

Memory Hierarchy, Multiprogramming (Fixed and Variable Partitions), Paging, Segmentation, Virtual Memory Concepts, Demand Paging, Page Replacement Algorithms (FIFO, LRU), Thrashing, Locality of Reference, File System Basics

**Problem solving:**

- Implement FIFO page-replacement algorithm.
- Implement LRU page-replacement algorithm.

| **Unit 5** | **Operating Systems: Case Studies and I/O Systems** | **10 hours** |
|---|---|---|

Types of OS: Batch, Time-Sharing, Real-Time, Embedded OS vs General Purpose OS, System Calls (fork), Shell vs Kernel Concepts.

**Problem solving:**

Write a C program using fork() to:

- Create a child process
- Display the PID and PPID
- Both parent and child should print different messages

| **Total Lecture Hours** | **60 hours** |
|---|---|

**Textbook:**

1. Korth, Silbertz, Sudarshan," Database Concepts", McGraw Hill
2. Silberschatz, Galvin and Gagne, "Operating Systems Concepts", Wiley
3. Elmasri, Navathe, " Fundamentals of Database Systems", Addision Wesley
4. Date C J, " An Introduction to Database Systems", Addision Wesley
5. D M Dhamdhere, "Operating Systems : A Concept basedApproach", McGraw Hill

**Reference Books:**

1. .Leon & Leon,"Database Management Systems", Vikas Publishing House
2. .Bipin C. Desai, " An Introduction to Database Systems", Gagotia Publications
3. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education"

**Mode of Evaluation:**

| **MSE** | | **CA** | | | **ESE** | **Total** |
|---|---|---|---|---|---|---|
| **MSE1** | **MSE2** | **CA1** | **CA2** | **CA3(ATT)** | | |
| 30 | 30 | 6 | 6 | 3 | **75** | **150** |
| **60** | | **15** | | | | |

| **Course Code: EL207E** | **Course Name: AI and Machine Learning for Smart Grids** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **2** | **4** |

**Pre-requisite:** NA

**Course Objectives:**

1. To introduce AI/ML fundamentals and their relevance in power systems and smart grids.
2. To develop skills for data acquisition, preprocessing, and analytics in smart grid scenarios.
3. To model and implement AI/ML solutions for load forecasting, fault detection, and demand-side management.
4. To expose students to industry-standard case studies, tools, and Tata Power-DDL's real-world implementations.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand and interpret the role of AI/ML in the evolution of smart grid systems.
2. Apply ML models for load forecasting, anomaly detection, and predictive analytics in power networks.
3. Implement AI/ML algorithms using Python and MATLAB on real-world or simulated smart grid datasets.
4. Evaluate AI/ML-based smart grid case studies, especially from Tata Power-DDL, and suggest improvements.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| **CO-PO Mapping** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 3 | - | - | - | - | 1 | - | 2 |
| **CO2** | 2 | 3 | 3 | 2 | 3 | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 2 | 3 | 3 | 2 | 3 | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 3 | 1 | 1 | - | 1 | 2 | 3 | 3 |

| **Unit 1** | **Introduction to AI and ML in Smart Grids** | **19 hours** |
|---|---|---|

Smart Grid recap (digitization, two-way communication, IoT, and DERs), AI/ML in power systems, Supervised vs Unsupervised learning; Overview of common models (LR, SVM, k-NN, Decision Trees, ANN), Smart grid data ecosystem: types, sources, and formats.

**Activities:**

- Import and explore power system datasets using Pandas and Matplotlib
- Simulate time-series power data and visualize trends using SCADA/Excel.

| **Unit 2** | **Load Forecasting using ML Techniques** | **19 hours** |
|---|---|---|

Short-term, medium-term, and long-term load forecasting, Regression models (Linear Regression, Ridge, Lasso), Neural Networks and LSTM models for time-series forecasting, Evaluation metrics (RMSE, MAPE, $R^2$)

**Activities:**

- Build and train a linear regression model to forecast daily load
- Implement LSTM-based load prediction using Keras/TensorFlow.

| **Unit 3** | **Fault Detection and Predictive Maintenance** | **19 hours** |
|---|---|---|

Nature of faults in transmission/distribution systems, Signal processing and feature extraction (FFT, DWT), Classification algorithms (SVM, Random Forest, CNN for fault identification), Predictive maintenance using anomaly detection and clustering (k-Means, DBSCAN)

**Activities:**

- Analyze voltage/current signal datasets using FFT in MATLAB
- Train a classifier for fault detection using SVM in Python.

| **Unit 4** | **Demand Response and Optimization using AI** | **18 hours** |
|---|---|---|

Demand response (DR) basics (TOU pricing, dynamic pricing, peak shaving), Optimization techniques (Genetic Algorithms, Reinforcement Learning), Consumer behavior prediction using unsupervised learning, Load disaggregation and demand-side flexibility.

**Activities:**

- Implement simple DR strategies using pricing signals in Python
- Simulate RL-based load control policy using OpenAI Gym.

| | **Total Lecture Hours** | **75 hours** |
|---|---|---|

**Textbook:**

1. Elissaios Sarmas et al., Artificial Intelligence for Energy Systems, Springer
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.

**Reference Books:**

1. Tata Power-DDL Technical Reports, Whitepapers
2. IEEE Transactions on Smart Grid
3. GitHub Repositories for Power System AI Projects
4. Online datasets: Kaggle, UCI ML Repository, OpenEI.

**Mode of Evaluation:**

| **MSE** | | **CA** | | | **ESE** | **Total** |
|---|---|---|---|---|---|---|
| **MSE1** | **MSE2** | **CA1** | **CA2** | **CA3(ATT)** | | |
| 40 | 40 | 8 | 8 | 4 | **100** | **200** |
| **80** | | **20** | | | | |

| **Course Code: EC211E** | **Course Name: Bio-Medical Electronics & Devices** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **2** | **4** |

**Pre-requisite:** NA

**Course Objectives:**

1. To Understand the effect of biomedical signals on the human body.
2. To understand and Analysis of biomedical signals obtained from the human body and electronic signals.
3. To develop a new system for the areas related to biomedical engineering.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand human activities on the basis of biomedical signals.
2. Analysis of biomedical signals obtained from the human body and electronic signals.

3. Identify, and solve the problems related to the area of biomedical engineering devices.
4. Design a new system, or process to achieve desired needs for solving a problem in biomedical electronics engineering.
5. Understand the testing analysis of the therapeutic equipment.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 1 | 2 | 2 | 1 | - | - | - | - | - | 1 |
| CO2 | 2 | 2 | 1 | 2 | 2 | 1 | - | - | - | - | - | 1 |
| CO3 | 2 | 1 | 1 | 2 | 2 | 2 | - | - | - | - | - | 1 |
| CO4 | 2 | 2 | 1 | 2 | 2 | 2 | - | - | - | - | - | 1 |
| CO5 | 2 | 2 | 2 | 2 | 3 | 2 | - | - | - | - | - | 1 |

| **Unit 1** | **Physiological systems and Signals** | **15 hours** |
|---|---|---|

Biology of the heart, circulatory and respiratory systems, auditory systems, physiology of nerve and muscle cells, fundamental organization of brain and spinal cord.
Bio signals: Origin of bioelectric signals, electrocardiogram (ECG), phonocardiogram (PCG), encephalogram (EEG), and electromyogram (EMG).

| **Unit 2** | **Physiological Transducers Electrodes** | **15 hours** |
|---|---|---|

Silver-silver chloride electrodes, electrodes for ECG, EEG, EMG, and Microelectrodes. Performance characteristics of transducers, classification of transducers based on Electrical principle involved: Resistive position transducer, resistive pressure transducer, inductive pressure transducer, capacitive pressure transducer; Self generating inductive transducer: linear variable differential transformer (LVDT), Piezoelectric Transducer.

| **Unit 3** | **Recording Systems** | **15 hours** |
|---|---|---|

Preamplifier, Signal conditioning: Differential amplifier, current to voltage converter, instrumentation amplifier; biomedical filters: LPF, HPF, bandpass, band stop (Notch filter); source of noise in low level measurement, Recording systems for ECG, PCG, EEG and EMG.

| **Unit 4** | **Medical Imaging Systems** | **15 hours** |
|---|---|---|

X-ray imaging, Computed tomography, ultrasonic imaging systems, Magnetic resonance imaging system, thermal imaging systems.

| **Unit 5** | **Therapeutic equipment's** | **15 hours** |
|---|---|---|

Cardiac pacemaker, cardiac defibrillators, hemodialysis machine.

| | **Total Lecture Hours** | **75 hours** |
|---|---|---|

**Textbook:**
1. Suresh R. Devasahayam, Signals and Systems in Biomedical Engineering: Physiological Systems Modeling and Signal Processing, Springer, 2019.
2. Dr R. S. Khandpur, Handbook of biomedical instrumentation, 3rd Edition, McGraw Hill Education (India).
3. Andreas Maier Stefan Steidl Vincent Christlein Joachim Hornegger (Eds.), Medical Imaging Systems, Springer.

**Reference Books:**
1. Devasahayam, Suresh R., Signals and systems in biomedical engineering: signal processing and physiological systems modeling, New York: Kluwer Academic/Plenum Publishers, c2000.
2. Richard S. C. Cobbold, Richard Cobbold (S. C.), Transducers for Biomedical Measurements: Principles and Applications, Wiley, 1974.
3. Leslie Cromwell, Biomedical Instrumentation and Measurement, 1st edition, Pearson Education, New Delhi, 2007.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

| Course Code: EC213E | Course Name: Analog Integrated Circuit Design | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**Pre-requisite:** NA

**Course Objectives:**
1. Introduce core concepts of analog IC design and CMOS technology using EDA tools.
2. Enable simulation of analog circuits like current mirrors and amplifiers.
3. Provide hands on experience in layout design, verification, and post-layout simulation using EDA Tool.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand CMOS technology and MOSFET behaviour for analog IC design.
2. Design and simulate key analog circuits like current mirrors and amplifiers.
3. Design and simulate key analog circuits like current mirrors and amplifiers.
4. Implement end-to-end analog design flow, from schematic to GDSII generation.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | - | - | 2 |
| CO2 | 3 | 3 | 2 | 2 | 3 | - | - | - | - | - | - | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | - | - | - | - | - | - | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 2 |

| | | |
|---|---|---|
| **Unit 1** | **Introduction to Analog IC Design & MOSFET Characterization** | **15 hours** |

Introduction to Analog IC Design, CMOS Technology Overview, Overview of Analog and Mixed-Signal ICs. Basics of Analog VLSI: Design flow overview, CMOS fabrication and process steps, MOSFET device physics: MOSFET I-V characteristics, Threshold voltage, body effect, channel length modulation effects, MOSFET models (long channel, short channel), DC analysis of NMOS/PMOS transistors using EDA Tool.

| | | |
|---|---|---|
| **Unit 2** | **Current Mirrors and Amplifier Circuits** | **15 hours** |

Basic, Cascode and Wilson current mirror. Common-source amplifier, Common Gate Amplifier and Source follower. Differential amplifier Circuit, Schematic design of current mirrors and differential amplifiers, DC and transient analysis using EDA Tool, Measurement of gain, output resistance, and CMRR.

| | | |
|---|---|---|
| **Unit 3** | **Introduction to IC Physical Design** | **15 hours** |

Introduction to IC Physical Design Flow, EDA tools for PD Flow. Functional Simulation, Schematic Capture using EDA Tool, Symbol Creation. Testbench Creation using Virtuoso Schematic Editor, Delay Estimation, Power estimation.

| | | |
|---|---|---|
| **Unit 4** | **Layout Design using EDA Tool** | **15 hours** |

Layout Design using EDA Tool, Layout Editor, Physical Verification which includes DRC & LVS, Parasitic Extraction, Post Layout Simulation, Generation of GDSII.

| | | |
|---|---|---|
| **Unit 5** | **Physical Implementation using EDA Tool** | **15 hours** |

Physical Implementation (Current Mirror Circuit as an example) using EDA Tool that includes- layout, Physical Verification, Parasitic Extraction, Post Layout Simulation, Generation of GDSII.

| | |
|---|---|
| **Total Lecture Hours** | **75 hours** |

**Textbook:**

1. Sedra & Smith, "Microelectronic Circuits", Oxford Publication
2. N.A.Sherwani , "Algorithms for VLSI Physical Design Automation", (3/e), Kluwer,1999.

**Reference Books:**

1. Behzad Razavi, "Fundamentals of Microelectronics", McGraw Hill Education
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill Education
3. Allen & Holberg, "CMOS Analog Circuit Design" Oxford Univ Press
4. R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation, , Wiley-IEEE, 3rd Edition, 2010.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

| Course Code: EE206E | Course Name: Integration of Systems of EVs | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**Pre-requisite:** NA

**Course Objectives:** Aim to equip the students with the skills to understand the system level architecture and integration of EV systems

**Course Outcome:** After completion of the course, the student will be able to

1. Identify key components and subsystems of an Electric Vehicle (EV), including the battery, motor, inverter, VCU, and charger.
2. Explain the functional role and interaction of EV subsystems such as battery packs, motors, controllers, and communication protocols.

3. Analyze EV powertrain performance and control architecture using software tools like ADVISOR, MATLAB, and CANalyzer.
4. Evaluate trade-offs in battery chemistry, BMS topologies, and subsystem integration choices based on functional and efficiency criteria.
5. Design a simplified EV subsystem integration framework using hardware-software interfacing, communication protocols, and control logic.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | - | - | 2 | 2 | 2 | - | - | - | - | 2 |
| CO2 | 2 | - | 2 | - | 2 | 2 | 2 | - | 2 | - | - | 2 |
| CO3 | 3 | - | 3 | 2 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| CO5 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |

**Unit 1 | EV Systems Architecture and Requirements | 15 hours**

Overview of EV systems and subsystems, Electric Vehicles in India, Forces acting when a vehicle move, Power and Torque calculations, Concept of Drive Cycle- Indian Drive Cycle and associated calculations, EV subsystem – Design of EV drive train.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Case Study of Forces acting on a Nissan Magnite
- Indian Drive Cycle – Excel Sheet Calculation to various drive scenarios.

**Unit 2 | Battery and Powertrain Subsystems Integration | 15 hours**

Introduction to batteries parameters, Cells and Batteries, Lithium-ion battery and Sodium Ion battery- Terminologies and Working, Parameters for selecting the cell chemistry, cell form factors, Parameters for designing battery pack configuration, Battery Management System, BMS Topology – Centralized, Master and Slave, Modular and Distributed, Introduction to Electric Powertrain.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- ADVISOR Tool Demonstration and conclusion.
- Case Study of White Paper – How Cells are Manufactured.
- Understanding Cell Data Sheet
- EV Database Website Demonstration

**Unit 3 | Electric Powertrain | 15 hours**

Components of an Electric Powertrain: Electric motors, Power electronics, Battery systems, Understanding Requirements from EV powertrain- Vehicle Load forces, Power, Energy and Speed relationships, Aerodynamic Drag, Rolling Resistance and Gradeability, Example- Tesla Model S (2013) and E-Rickshaw power demand Calculations, Battery Electric Vehicle Range at Constant Speed, Vehicle Acceleration- Traction Motor Characteristics, 2015 Nissan Leaf Rated Speed, Simplified Traction Machine Torque-Speed Characteristic (MATLAB Script Code)

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Case Study of Force calculations of Nissan Micra
- Simplified Machine Torque-Speed Characteristics of a Motor (MatLaB Script Code Demonstration)

**Unit 4 | Fundamental of Control System Integration | 15 hours**

Microprocessor Architecture: Internal architecture of microprocessors, Key components: ALU, registers, control unit, Memory Interfacing: Addressing schemes and memory organization, Interfacing with RAM and ROM in automotive applications, Input/Output Interfacing: Basics of I/O interfacing, 8086 and 8087 microprocessors

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- CANalyzer – Case Study

**Unit 5 | Communication Protocols | 15 hours**

Controller Area Network (CAN) Protocol: Basics of the CAN protocol, Message format, Bus Arbitration, CAN in-vehicle networking for communication between ECUs, LIN (Local Interconnect Network) and Flex Ray-Overview of LIN and Flex Ray protocols, Applications and advantages in automotive systems-LIN in Interior Lighting control, FlexRay in Advanced Driver Assistance Systems (ADAS)

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- CAN Cable Demonstration

**Total Lecture Hours | 75 hours**

**Textbook:**

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Ali Emadi, Crc Press
2. The 8051 Microcontrollers: Architecture, Programming and Applications By Kenneth J Ayala, Cengage India Private Limited

**Reference Books:**

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Ali Emadi, Crc Press

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

| Course Code: EE208E | Course Name: Integration of SCADA and PLC with IIOT Gateways | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**Pre-requisite:** NA

**Course Objectives:** Aim to give exposure to the students about Sensors & Automation which are required in industry.

**Course Outcome:** After completion of the course, the student will be able to

1. Understand the types of SCADA and Data sharing between PLC.
2. Understand the Real-time Data Analytics in SCADA Systems using IIoT Edge Devices.
3. Apply the IIoT-Enabled Data Interfacing for ERP Systems.
4. Apply the data types involved in PLC & IIOT Gateway
5. Develop the real time application covering of IIOT.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | - | - | 2 | 2 | 2 | - | - | - | - | 2 |
| CO2 | 2 | - | 2 | - | 2 | 2 | 2 | - | 2 | - | - | 2 |
| CO3 | 3 | - | 3 | 2 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| CO5 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |

**Unit 1 Introduction SCADA** — **15 hours**

Introduction to SCADA, SCADA software types, Tags concepts of SCADA, SCADA programming along with report generation using VB scripting. Data sharing between PLC and SCADA software.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- SCADA Programming and Simulated Report Generation using VB Scripting
- Simulated Data Exchange Between Virtual PLC and SCADA

**Unit 2 Real-time Data Analytics in SCADA Systems using IIoT Edge Devices** — **15 hours**

Designing a hybrid SCADA-IIOT architecture, Real-time Data Analytics Techniques, how edge devices communicate with SCADA and cloud., Data formats (JSON, XML).

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Design and Simulation of a Hybrid SCADA-IIoT Architecture
- Implementation of Cloud Connectivity in SCADA via IoT Gateways
- Data Format Handling and Parsing: JSON vs XML in IIoT Applications
- Edge Device Communication with SCADA and Cloud via MQTT Protocol

**Unit 3 IIoT-Enabled Data Interfacing for ERP Systems** — **15 hours**

Architecture overview: Edge device → Gateway → ERP system (How data moves from sensors/machines to ERP via IIoT gateways), Types of data shared (e.g., machine status, production metrics, energy consumption)., Benefits of energy monitoring system.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Simulating Edge-to-ERP Data Flow in a SCADA-IIoT Architecture
- Role and Simulation of IIoT Gateways in Industrial Communication
- Design and Simulation of an Energy Monitoring System

**Unit 4 Data Types involved in PLC & IIOT Gateway** — **15 hours**

Boolean (Binary Data), Integer, Float / Real, String (Device names, status messages, error codes, configuration parameters), Date Time / Timestamp.

**Hands-on/Case Study/ Mini-Project/ Problem solving:**

- Handling Boolean (Binary) Data for Machine Status and Control
- Transmission and Logging of Integer and Float Data in SCADA-IIoT

| | | |
|---|---|---|
| • Using Strings in SCADA for Device Identification and Messaging | | |
| **Unit 5** | **Application Development** | **15 hours** |
| Developing real time application covering all above topics (Edge device → Gateway → ERP system) **Hands-on/Case Study/ Mini-Project/ Problem solving:**<br>• Real-Time Data Analytics and Visualization using Dashboards<br>• Simulation of Edge Device Data Generation Using Multiple Data Types<br>• Simulating Data Exchange from Gateway to ERP System | | |
| | **Total Lecture Hours** | **75 hours** |

**Textbook:**

1. S. K. Singh, *Industrial Automation and Control*. New Delhi, India: McGraw Hill, 2016.
2. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, *Industrial Internet of Things: Cyber manufacturing Systems*. Cham, Switzerland: Springer, 2017.

**Reference Books:**

1. S. G. McCrady, *Designing SCADA Application with VB and Database*. Oxford, UK: Elsevier, 2006.
2. R. Buyya and A. V. Dastjerdi, *Internet of Things: Principles and Paradigms*. Cambridge, MA, USA: Morgan Kaufmann, 2016.
3. S. A. Boyer, *SCADA: Supervisory Control and Data Acquisition*, 4th ed. Durham, NC, USA: ISA, 2009.
4. T. Winters, *Practical Industrial Internet of Things (IIoT): A Guide to Smart Manufacturing and Industry 4.0*. Birmingham, UK: Packt Publishing, 2020.

**Mode of Evaluation:**

| MSE | | CA | | | ESE | Total |
|---|---|---|---|---|---|---|
| MSE1 | MSE2 | CA1 | CA2 | CA3(ATT) | | |
| 40 | 40 | 8 | 8 | 4 | 100 | 200 |
| 80 | | 20 | | | | |

# Practical Courses Detail Syllabus

| Course Code: EL104P | Course Name: Electrical Machines Lab | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**Pre-requisite:** Electrical measurement techniques, Industrial Safety & Handling of Electrical Machines

**Course Objectives:**

1. To enable students to analyze the performance characteristics of electrical machines.
2. To obtain performance indices using standard analytical and graphical methods.
3. To demonstrate procedural steps for conducting basic tests on electrical machines.
4. To explore industrial applications of electrical machines.

**Course Outcome:** After completion of the course, the student will be able to

1. Develop understanding to determine operational performance of transformers and dc machines.
2. Understand the performance characteristics of induction motors.
3. Understand operation of synchronous machines based on V-curves and voltage regulation.
4. Demonstrate the synchronization of an alternator with an infinite bus.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | 2 | - | - | - | 1 | - | - | - |
| CO2 | 3 | 2 | - | - | 2 | - | - | - | 1 | - | - | - |
| CO3 | 3 | 2 | - | - | 2 | - | - | - | 1 | - | - | - |
| CO4 | 3 | 2 | - | - | - | - | - | - | 1 | - | - | - |

**List of Practical's (Indicative & not limited to)**

**Hardware based experiments**

1. To obtain equivalent circuit, efficiency and voltage regulation of a single-phase transformer using O.C, S.C. and Sumprner's tests.
2. To determine the open-circuit and load characteristics of a DC shunt generator.
3. To perform no load and blocked rotor tests on a three-phase squirrel cage induction motor and determine equivalent circuit.
4. To study and compare the performance of DOL and Star-Delta starters.
5. To determine V-curves and inverted V-curves of a three-phase synchronous motor.

6. To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method.

**Software based experiments**

7. To simulate and analyze the performance of a single-phase transformer under no-load and loaded conditions using MATLAB.
8. To simulate and analyze the effect of armature voltage and field current variation on the speed of a DC shunt motor.
9. To simulate and analyze the torque-speed characteristics of a three-phase induction motor using MATLAB.
10. To simulate the open circuit and short circuit tests of a synchronous generator and determine its synchronous reactance and voltage regulation using MATLAB.
11. To simulate the starting behavior of a synchronous motor through damper winding method by using MATLAB.
12. To simulate an alternator connected in parallel with an infinite bus and analyze the effect of change in excitation and prime mover input.

| | |
|---|---|
| **Total Hours** | **30 hours** |

**Mode of Evaluation:**

| CA | | ESE | Total |
|---|---|---|---|
| CA1 | CA2 | | |
| 12 | 13 | 25 | 50 |
| 25 | | | |

| Course Code: EL202P | Course Name: Control Engineering Lab | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**Pre-requisite:** Basic Electrical Engineering, Differential Equations, Linear Algebra, Signals & Systems

**Course Objectives:**

1. To understand the different types of control systems and their application in practical life.
2. To understand the concept of stability and its assessment for linear-time invariant systems in time domain and in frequency domain.

**Course Outcome:** After completion of the course, the student will be able to

1. Analyze the behavior of control systems using experimental setups and simulation tools.
2. Evaluate control system responses using time-domain and frequency-domain techniques.
3. Implement and tune PID controllers in real-time and simulated environments for various applications.
4. Interpret the performance of physical control systems through hands-on experiments and computational modeling.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | - | - | 2 | 2 | 2 |

**List of Practical's (Indicative & not limited to)**

**Hardware-Based Experiments**

1. To determine the step response of first order and second order systems using linear system simulator.
2. To determine the speed-torque characteristics of an ac servomotor.
3. To simulate and compare the response of 2nd order system with and without Lead, Lag and Lead-Lag compensator.
4. To study synchro-transmitter and receiver and obtain output vs input characteristics.
5. To study characteristics of positional error detector by angular displacement of two servo potentiometers.
6. To study the behavior of separately excited dc motor in open loop and closed loop conditions at various loads.
7. To study P, PI and PID temperature controller for an oven and compare their characteristics.
8. To study the performance of a Servo voltage stabilizer at various loads using load bank.

**Software-Based Experiments (MATLAB/ Scilab or any equivalent open-source software)**

1. Determine the Step Responses of a second order system using MATLAB.
2. To convert transfer function of a system into state space form and vice-versa.
3. To plot root locus diagram of an open loop transfer function and determine the stability.
4. To plot a Bode diagram of an open loop transfer function and determine the stability.
5. To draw a Nyquist plot of an open loop transfers functions and examine the stability of the closed loop system.
6. Simulate and Tune PID Controller in Simulink for Various Plant Models.

| | |
|---|---|
| **Total Hours** | **30 hours** |

**Mode of Evaluation:**

| CA | | ESE | Total |
|---|---|---|---|
| CA1 | CA2 | | |
| 12 | 13 | 25 | 50 |
| 25 | | | |

| Course Code: EL203P | Course Name: Electrical Power Systems Lab | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**Pre-requisite:** Basic Electrical Engineering Concepts, Introductory Knowledge of Power Systems, Familiarity with MATLAB/Simulink, Exposure to DIgSILENT PowerFactory.

**Course Objectives:**

1. To provide hands-on experience in modeling and simulating electrical power system components using MATLAB/Simulink and DIgSILENT PowerFactory.
2. To develop practical skills for analysing power system behaviour under normal and fault conditions.
3. To familiarize students with power flow analysis, system stability, and fault analysis techniques in power networks.
4. To enable students to evaluate one of the major power quality issues of harmonics in power systems.

**Course Outcome:** After completion of the course, the student will be able to

1. Simulate and analyse electrical transmission line models and parameters using MATLAB/Simulink.
2. Perform power flow and fault analysis using simulation tools for understanding steady-state and faulted system behaviour.
3. Evaluate system stability and transient response under fault conditions using MATLAB/Simulink and DIgSILENT PowerFactory.
4. Analyse voltage and current harmonics in power systems.

**CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)**

| CO-PO Mapping | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | - | - | - | 2 | 2 | 2 | - | - | - | - | 2 |
| CO2 | 2 | - | 2 | - | 2 | 2 | 2 | - | 2 | - | - | 2 |
| CO3 | 3 | - | 3 | 2 | 3 | 2 | 2 | - | 2 | - | - | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | 2 |

**List of Practical's (Indicative & not limited to)**

**MATLAB/Simulink-Based Experiments**

1. Calculate and plot inductance and capacitance of single-phase and three-phase lines using MATLAB.
2. Simulate Ferranti Effect on lightly loaded long transmission line using Simulink.
3. Compute ABCD constants and simulate voltage regulation for short/medium/long lines using Simulink.
4. Perform load flow analysis on a 3-bus IEEE system using Gauss-Seidel method in MATLAB.
5. Simulate L-G, L-L, LLG, and 3-phase faults in a power system using Simulink/Simscape Electrical.
6. Analyze rotor angle stability using swing equation (point-by-point method) in MATLAB or Simulink..

**DIgSILENT PowerFactory-Based Experiments**

1. Model a basic power system network to simulate generation, transmission, and distribution structure.
2. Simulate corona onset voltage and observe its effect online losses and transmission performance.
3. Perform load flow analysis using PowerFactory and compare results with MATLAB output.
4. Inject symmetrical and unsymmetrical faults and analyze system voltage and current responses.
5. Simulate generator rotor dynamics under fault and clearing conditions for stability study.
6. Perform harmonic analysis to identify THD levels in a power system with nonlinear electrical loads.

| | |
|---|---|
| **Total Hours** | **30 hours** |

**Mode of Evaluation:**

| CA | | ESE | Total |
|---|---|---|---|
| CA1 | CA2 | | |
| 12 | 13 | 25 | 50 |
| 25 | | | |