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PATAN, GUJARAT

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MK University, Patan
Faculty of Engineering Technology,
Department of Electrical Engineering

DIPLOMA (ELECTRICAL ENGINEERING) SEM-I									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/WEEK	PRACTICAL (HRS.)/WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	DEE101	ENGINEERING MATHEMATICS-I	4	0	4	40	60	100
2	MAJOR	DEE102	ENGINEERING PHYSICS	4	2	6	90	60	150
3	MAJOR	DEE103	ENGINEERING CHEMISTRY	4	2	6	90	60	150
4	MAJOR	DEE104	BASICS OF ELECTRICAL ENGINEERING	4	2	6	90	60	150
5	MINOR	DEE105	WORKSHOP PRACTICE	0	2	2	50	00	50
TOTAL				16	8	24	360	240	600

DIPLOMA (ELECTRICAL ENGINEERING) SEM-II									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/WEEK	PRACTICAL (HRS.)/WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	DEE201	ENGINEERING MATHEMATICS-II	4	0	4	40	60	100
2	MAJOR	DEE202	ELECTRICAL CIRCUITS & NETWORKS	4	2	6	90	60	150
3	MAJOR	DEE203	ELECTRONICS-I	4	2	6	90	60	150
4	MINOR	DEE204	ELECTRICAL MEASUREMENTS	4	2	6	90	60	150
5	SEC	DEE205	COMMUNICATION SKILL	2	0	2	00	50	50
TOTAL				18	6	24	310	290	600

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DIPLOMA (ELECTRICAL ENGINEERING) SEM-III									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/ WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	DEE301	ELECTRICAL MACHINES-I	4	2	6	90	60	150
2	MAJOR	DEE302	POWER SYSTEMS-I	4	2	6	90	60	150
3	MAJOR	DCEE303	DIGITAL ELECTRONICS	4	2	6	90	60	150
4	MINOR	DEE304	INDUSTRIAL VISIT REPORT	0	2	2	50	00	50
5	IKS	DEE305	IKS-ANNCIENT INDIAN ENGINEERING PRACTICE	0	2	2	50	00	50
TOTAL				12	10	22	370	180	550

DIPLOMA (ELECTRICAL ENGINEERING) SEM-IV									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/ WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	DEE401	ELECTRICAL MACHINES-II	4	2	6	90	60	150
2	MAJOR	DEE402	POWER SYSTEMS-II	4	2	6	90	60	150
3	MAJOR	DEE403	MICROPROCESSORS & APPLICATIONS	4	0	4	40	60	100
4	MINOR	DEE404	RENEWABLE ENERGY SYSTEMS	4	0	4	40	60	100
5	VAC	DEE405	ENVIRONMENTAL SCIENCE	2	0	2	00	50	50
TOTAL				18	4	22	260	290	550

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DIPLOMA (ELECTRICAL ENGINEERING) SEM-V									
SR NO.	COURSE TYPE	COURSECODE	CORSENAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	DEE501	CONTROL SYSTEMS	4	2	6	90	60	150
2	MAJOR	DEE502	ELECTRICAL DRIVES	4	0	4	40	60	100
3	MAJOR	DEE503	POWER ELECTRONICS	4	2	6	90	60	150
4	MINOR	DEE504	SMART GRID & IOT	4	0	4	40	60	100
5	SEC	DEE505	MIN PROJECT	0	2	2	50	00	50
TOTAL				16	6	22	310	240	550

DIPLOMA (ELECTRICAL ENGINEERING) SEM-VI									
SR NO.	COURSE TYPE	COURSECODE	CORSENAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	DEE601	SWITCHGEAR & PROTECTION	4	2	6	90	60	150
2	MAJOR	DEE602	INDUSTRIAL AUTOMATION	4	2	6	90	60	150
3	MAJOR	DEE603	ENERGY MANAGEMENT & AUDIT	4	2	6	90	60	150
4	MINOR	DEE604	DIPLOMA PROJECT	0	6	6	150	00	150
TOTAL				12	12	24	420	180	600

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SEMESTER-I

COURSE CODE: DEE101

COURSE NAME: ENGINEERING MATHEMATICS-I

Course Objectives:

- To develop foundational mathematical skills essential for mechanical engineering applications
- To apply algebraic, trigonometric, and calculus concepts to solve engineering problems
- To interpret and analyze data using statistical methods
- To build problem-solving abilities through applied mathematics
- To prepare students for advanced engineering mathematics in subsequent semesters

Course Outcomes: At the end of the course students shall be able to

CO1	**Solve** algebraic equations and apply them to engineering problems
CO2	**Apply** trigonometric functions to analyze mechanical systems
C03	**Perform** basic differentiation and integration relevant to engineering applications
C04	**Analyze** data using measures of central tendency and dispersion

Unit	Content	Credit	Weightage
I	**Algebra and Trigonometry** **Topics:** • **Algebra:** Quadratic equations, simultaneous linear equations (2 and 3 variables) • Arithmetic and geometric progressions • **Trigonometry:** Trigonometric ratios, identities, compound angles • Heights and distances (engineering applications) • Complex numbers: basics and operations • **Applications:** Simple harmonic motion, projectile motion, force resolution	1	25%

II	**Differential Calculus**
	Topics:
	• Functions, limits, and continuity
	• Derivatives: Standard formulas
	• Rules of differentiation: Product, quotient, chain rule
	• Applications of derivatives:
	  ○ Rate of change (velocity, acceleration)
	  ○ Maxima and minima (optimization problems)
	  ○ Tangents and normals
	• Partial differentiation (introduction)
	• **Applications:** Optimization in design, motion analysis, slope of curves
		1	25%

III	**Integral Calculus** **Topics:** • Indefinite integrals: Standard formulas	1	25%

	• Methods of integration: Substitution, integration by parts
	• Definite integrals and properties
	• Applications of integration:
	  ○ Area under curves
	  ○ Volume of solids of revolution
	  ○ Center of gravity/centroid (basic concepts)
	• **Applications:** Area calculation in engineering drawings, volume of tanks/containers		

IV	**Statistics and Probability** **Topics:** • **Statistics:** Data classification, frequency distribution • Measures of central tendency: Mean, median, mode • Measures of dispersion: Range, standard deviation, variance • Graphical representation: Histogram, frequency polygon, ogive • **Probability:** Basic concepts, addition and multiplication theorems • **Applications:** Quality control, measurement analysis, manufacturing data interpretation	1	25%

Textbooks:

- Primary: *Engineering Mathematics* — NP Bali & Dr. Manish Goyal
- Primary: *A Textbook of Engineering Mathematics* — B.S. Grewal

Reference books:

- *Advanced Engineering Mathematics* — H.K. Das
- *Engineering Mathematics* — D. G. Gupta
- *Basic Technical Mathematics with Calculus* — Allyn J. Washington
- *Mathematics for Mechanical Engineering* — B.V. Ramana

Online Platforms:

1. NPTEL Videos: "Basic Course in Mathematics" for engineering
2. Coursera: "Pre-Calculus" by University of California, Irvine

COURSE CODE: DEE102

COURSE NAME: ENGINEERING PHYSICS

Course Objectives:

- To understand fundamental physics principles relevant to mechanical engineering
- To apply physics concepts to solve practical engineering problems
- To develop skills in measurement, experimentation, and data analysis
- To correlate theoretical physics with mechanical systems and applications
- To build foundation for advanced engineering courses

Course Outcomes: At the end of the course students shall be able to

CO1	**Apply** mechanics principles to analyze forces, motion, and energy in mechanical systems
CO2	**Explain** thermal physics concepts relevant to heat engines and refrigeration
C03	**Demonstrate** understanding of optics and acoustics in

	engineering contexts
C04	**Perform** measurements using physical instruments and analyze experimental data

Unit	Content	Credit	Weightage
I	**Mechanics & Properties of Matter** **Topics:** • Scalars and vectors, force resolution, moment of force • Laws of motion, friction, work, energy, power • Circular motion, centripetal force • Elasticity: Stress, strain, Hooke's law, Young's modulus • Surface tension and viscosity (basic concepts) • **Applications:** Machine design, material strength, fluid mechanics basics	1	25%
II	**Thermal Physics & Thermodynamics** **Topics:** • Heat and temperature, thermal expansion • Calorimetry, specific heat capacity • Laws of thermodynamics (zeroth, first, second) • Heat transfer: conduction, convection, radiation • Kinetic theory of gases (basic) • **Applications:** Heat engines, refrigeration, insulation materials	1	25%
III	**Waves, Optics & Acoustics** **Topics:** • Simple harmonic motion, wave motion • Sound: characteristics, intensity, Doppler effect • Ultrasonics and applications • Reflection, refraction, lenses, optical instruments • Fiber optics (basic principles) • **Applications:** Machine vibration, NDT, optical measurements, noise control	1	25%
IV	**Modern Physics & Material Science** **Topics:** • Quantum physics basics: photons, matter waves • Lasers: principles, types, applications • Semiconductors: basics • Superconductivity (elementary concepts) • Nanotechnology introduction • **Applications:** Laser machining, sensors, advanced materials	1	25%

Textbooks:

- Primary: *Engineering Physics* — D. R. Khanna & H. N. Srivastava
- Primary: *Engineering Physics* — R. K. Gaur & S. L. Gupta

Reference books:

- *Fundamentals of Physics* — Halliday, Resnick & Walker
- *Concepts of Physics* — H. C. Verma

- *Engineering Physics* — M. N. Avadhanulu & P. G. Kshirsagar
- *Practical Physics* — C. L. Arora

Online Platforms:

- SWAYAM/NPTEL: "Engineering Physics" courses by IITs/NITs

PRACTICAL LIST:

Section A: Mechanics

1. Vernier Calipers & Screw Gauge: Measurement of dimensions of given objects
2. Simple Pendulum: Determination of 'g' and study of laws of pendulum
3. Young's Modulus: By Searle's method or cantilever
4. Coefficient of Friction: Using inclined plane
5. Force Table: Verification of law of parallelogram of forces

Section B: Thermal Physics

6. Specific Heat Capacity: Of solid/liquid using calorimeter
7. Thermal Conductivity: Of good conductor (Searle's apparatus)
8. Mechanical Equivalent of Heat: Using Joule's calorimeter
9. Coefficient of Linear Expansion: Using optical lever

Section C: Waves & Optics

10. Sonometer: Verification of laws of vibrating strings
11. Melde's Experiment: Transverse and longitudinal modes
12. Compound Pendulum: Determination of 'g' and radius of gyration
13. Optical Bench: Focal length of convex lens
14. Prism: Refractive index using spectrometer

Section D: Modern Physics

15. LASER: Determination of wavelength using diffraction grating
16. Photoelectric Effect: Verification of Einstein's equation
17. PN Junction Diode: Characteristics
18. Thermistor: Temperature-resistance characteristics

COURSE CODE: DEE103

COURSE NAME: ENGINEERING CHEMISTRY

Course Objectives:

- To provide fundamental knowledge of chemistry relevant to mechanical engineering applications
- To understand material properties, corrosion, fuels, and lubricants from chemical perspective
- To develop skills in chemical analysis, quality control, and material testing
- To correlate chemical principles with mechanical systems and manufacturing processes
- To build foundation for materials science, metallurgy, and environmental engineering

Course Outcomes: At the end of the course students shall be able to

CO1	**Explain** water treatment processes for industrial applications
CO2	**Analyze** properties of fuels and lubricants used in mechanical systems
C03	**Identify** corrosion mechanisms and prevention methods
C04	**Apply** principles of electrochemistry to batteries and corrosion control

Unit	Content	Credit	Weightage

I	**Water Chemistry & Treatment** **Topics:** • Water impurities: hardness, alkalinity, pH • Water softening methods: lime-soda, ion exchange • Boiler feed water treatment: scale and sludge formation, prevention • Cooling water treatment • Drinking water standards • **Applications:** Boiler operations, cooling systems, industrial water supply	1	25%
II	**Fuels & Combustion** **Topics:** • Classification of fuels: solid, liquid, gaseous • Calorific value determination: bomb calorimeter • Solid fuels: coal analysis (proximate & ultimate) • Liquid fuels: petroleum refining, petrol, diesel, octane/cetane number • Gaseous fuels: LPG, CNG, biogas • Combustion calculations • **Applications:** IC engines, furnaces, power generation	1	25%
III	**Lubricants & Corrosion** **Topics:** • Lubrication: mechanisms, types of lubricants • Properties: viscosity index, flash point, pour point • Additives in lubricants • Corrosion: types, mechanisms (electrochemical) • Factors affecting corrosion • Corrosion prevention methods • **Applications:** Machine maintenance, automotive, industrial equipment	1	25%
IV	**Engineering Materials & Polymers** **Topics:** • Cement: composition, setting and hardening • Refractories: properties, classification • Polymers: addition, condensation, engineering plastics • Composite materials: introduction • Batteries: primary, secondary, fuel cells • **Applications:** Construction materials, polymers in engineering, energy storage	1	25%

Textbooks:

- Primary: *Engineering Chemistry* — Jain & Jain
- Primary: *Engineering Chemistry* — Dr. O. P. Verma

Reference books:

- *A Textbook of Engineering Chemistry* — S. S. Dara & S. S. Umare
- *Engineering Chemistry* — R. P. Mani & K. N. Mishra
- *Chemistry for Engineering Students* — B. S. Jai Prakash & R. Venugopal
- *Applied Chemistry* — H. D. Gesser

Online Platforms:

- SWAYAM/NPTEL: "Engineering Chemistry" courses by IITs
- Khan Academy: Chemistry fundamentals
- MERLOT: Chemistry learning materials

PRACTICAL LIST:

Section A: Water Analysis

1. Determination of Hardness: By EDTA titration method
2. Alkalinity Determination: Using acid-base titration
3. pH Measurement: Using pH meter/universal indicator
4. Chloride Content: By argentometric method

Section B: Fuels & Lubricants

5. Viscosity Measurement: Using Ostwald viscometer/Redwood viscometer
6. Flash Point Determination: Using Abel/Pensky Martens apparatus
7. Calorific Value: Bomb calorimeter demonstration
8. Saponification Value: Of oil sample

Section C: Corrosion & Electrochemistry

9. Corrosion Rate Measurement: Weight loss method
10. Galvanic Series Determination
11. Electroplating: Copper plating on iron
12. EMF Measurement: Of simple galvanic cell

Section D: Materials & Polymers

13. Cement Setting Time: Initial and final setting time
14. Polymer Identification Tests
15. Preparation of Polymer: Phenol-formaldehyde/Bakelite
16. Refractory Properties: Porosity, thermal shock resistance

COURSE CODE: DEE104

COURSE NAME: BASICS OF ELECTRICAL ENGINEERING

Course Objectives:

- To introduce fundamental concepts of electricity and electrical circuits.
- To understand DC and AC circuit analysis techniques.
- To learn about basic electrical components, instruments, and safety practices.
- To develop skills in solving simple electrical engineering problems.
- To prepare students for advanced courses in electrical engineering.

Course Outcomes: At the end of the course students shall be able to

CO1	**Explain** basic electrical terms, laws, and circuit elements.
CO2	**Analyze** DC circuits using Ohm's Law, Kirchhoff's Laws, and network theorems.
C03	**Analyze** AC circuits with R, L, C components and calculate power in AC systems.
C04	**Operate** basic electrical measuring instruments and perform simple wiring tasks.

Unit	Content	Credit	Weightage
I	**Introduction to Electrical Fundamentals** **Topics:**	1	25%

	• Basic electrical quantities: Voltage, Current, Resistance, Power, Energy • Ohm's Law and its applications • Types of circuits: Open, Closed, Short • Conductors, Insulators, Semiconductors • Electrical Safety: Hazards, precautions, earthing, fuses, MCBs • Introduction to electrical symbols and wiring diagrams **Applications:** Simple circuit design, safety practices in electrical installations.		

II	**DC Circuit Analysis**
	Topics:
	• Series and parallel circuits
	• Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL)
	• Network theorems:
	  ○ Superposition Theorem
	  ○ Thevenin's Theorem
	  ○ Norton's Theorem
	  ○ Maximum Power Transfer Theorem
	• Voltage and current division rules
	• Mesh and Nodal analysis (basic)
	• **Applications:**
	Battery circuits, resistor networks, DC power supply design.
		1	25%

III	**AC Fundamentals** **Topics:** • Generation of AC voltage • RMS, Average, Peak values, Form Factor, Peak Factor • Phasor representation of AC quantities • Behavior of R, L, C in AC circuits • Series and parallel RLC circuits • Power in AC circuits: Active, Reactive, Apparent power, Power Factor • Introduction to three-phase systems: Star and Delta connections **Applications:** Domestic wiring, power factor correction, motor starting circuits.	1	25%

IV	**Electrical Measurements & Components**
	Topics:
	• Electrical measuring instruments:
	  ○ Analog: PMMC, Moving Iron, Dynamometer
	  ○ Digital: Multimeter, Clamp Meter
	• Measurement of voltage, current, resistance, power, energy
	• Introduction to transformers: Working principle, types,
		1	25%

	applications • Basic electrical components: Switches, relays, connectors, cables • Introduction to batteries: Types, ratings, charging methods **Applications:** Use of test equipment, transformer connections, battery maintenance.		

Textbooks:

- Primary: *Basic Electrical Engineering* – V.K. Mehta & Rohit Mehta (S. Chand)
- Primary: *Fundamentals of Electrical Engineering* – B.L. Theraja (S. Chand)

Reference books:

- *Principles of Electrical Engineering* – V.K. Mehta
- *Electrical Technology* – B.L. Theraja & A.K. Theraja
- *A Textbook of Electrical Technology* – S. Chand (Vol. 1)
- *Electrical Engineering Fundamentals* – Vincent Del Toro
- *Introduction to Electrical Engineering* – Mulukutla S. Sarma

Online Platforms:

1. NPTEL:
   - "Basic Electrical Circuits" by IIT Kharagpur
   - "Fundamentals of Electrical Engineering" by IIT Madras
2. Coursera:
   - "Introduction to Electronics" by Georgia Tech

PRACTICAL LIST:

Section A: Basic Measurements & Safety

- Identification of Electrical Components:
  Resistors, capacitors, inductors, fuses, switches, cables.
- Use of Digital Multimeter:
  Measurement of voltage, current, resistance.
- Electrical Safety Practices:
  Demonstration of earthing, use of PPE, handling of tools.
  - Section B: DC Circuits
- Verification of Ohm's Law
- Series and Parallel Resistance Circuits
- Verification of Kirchhoff's Laws
- Verification of Superposition Theorem
- Verification of Thevenin's Theorem
- Verification of Maximum Power Transfer Theorem
  - Section C: AC Circuits
- Study of AC Waveforms using CRO
- Measurement of RMS and Average values of AC
- Study of R, L, C in AC Circuits
- Power Factor Measurement and Improvement
- Study of Single-Phase Transformer

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SEMESTER-II

COURSE CODE: DEE201

COURSE NAME: ENGINEERING MATHEMATICS-II

Course Objectives:

- To build advanced mathematical skills for engineering problem-solving
- To apply differential equations to model mechanical systems
- To understand vector algebra and its applications in mechanics
- To develop skills in numerical methods for engineering computations
- To prepare mathematical foundation for subjects like Mechanics, Thermodynamics, and Machine Design

Course Outcomes: At the end of the course students shall be able to

CO1	**Solve** ordinary differential equations relevant to engineering systems
CO2	**Apply** vector algebra to analyze forces and motions in 3D space
C03	**Perform** numerical computations using interpolation, differentiation, and integration methods
C04	**Analyze** data using probability distributions and statistical methods

Unit	Content	Credit	Weightage
I	**Differential Equations** **Topics:** • First order differential equations: variable separable, homogeneous, exact • Linear differential equations of first order • Applications: Newton's law of cooling, growth and decay, simple circuits • Second order linear differential equations with constant coefficients • Complementary function and particular integral methods • **Applications:** Spring-mass systems, electrical circuits, vibration analysis	1	25%
II	**Vector Algebra & 3D Geometry** **Topics:** • Vectors: dot product, cross product, scalar triple product • Vector differentiation • Gradient, divergence, curl (basic concepts) • Lines and planes in 3D space • Direction cosines and ratios • **Applications:** Force analysis, moment of force, work done by force	1	25%
III	**Numerical Methods** **Topics:** • Solution of algebraic equations: Bisection method,	1	25%

	Newton-Raphson method • Interpolation: Newton's forward and backward difference formulas • Numerical differentiation and integration • Trapezoidal rule and Simpson's rules • **Applications:** Root finding in design equations, area calculations, data analysis		
IV	**Probability & Laplace Transforms** **Topics:** • **Probability:** Basic concepts, addition and multiplication theorems • Random variables, probability distributions (Binomial, Poisson, Normal) • Mean, variance, standard deviation • **Laplace Transforms:** Definition, basic transforms • Properties: linearity, shifting, differentiation • Application to differential equations • **Applications:** Quality control, reliability analysis, system dynamics	1	25%

Textbooks:

- Primary: *Higher Engineering Mathematics* — B.S. Grewal
- Primary: *Engineering Mathematics* — NP Bali & Dr. Manish Goyal

Reference books:

- *Advanced Engineering Mathematics* — H.K. Das
- *Numerical Methods* — S.S. Sastry
- *Probability and Statistics for Engineers* — Dr. J. Ravichandran
- *Mathematical Methods* — B.V. Ramana

Online Platforms:

- NPTEL Videos: "Differential Equations for Engineers"
- Khan Academy: Complete probability and statistics
- MIT OCW: "Single Variable Calculus" continuation
  Coursera: "Introduction to Numerical Methods"

COURSE CODE: DEE202

COURSE NAME: ELECTRICAL CIRCUITS AND NETWORKS

Course Objectives:

- To develop a strong foundation in electrical circuit theory and network analysis.
- To analyze DC and AC circuits using advanced network theorems and methods.
- To study frequency response, resonance, and transient behavior in circuits.
- To introduce network topology, two-port networks, and filter concepts.
- To equip students with skills to solve complex electrical network problems.

Course Outcomes: At the end of the course students shall be able to

CO1	**Apply** network theorems to solve complex DC and AC circuits.
CO2	**Analyze** transient and steady-state behavior of RLC circuits.
C03	**Determine** frequency response, resonance, and filter

	characteristics.
C04	**Model** two-port networks and solve using network parameters.

Unit	Content	Credit	Weightage

I	**Advanced DC and AC Network Analysis**
	Topics:
	• Review of basic laws: Ohm's Law, KCL, KVL
	• Mesh and Nodal analysis for DC and AC circuits
	• Network theorems (AC versions):
	  ○ Superposition Theorem
	  ○ Thevenin's and Norton's Theorems
	  ○ Maximum Power Transfer Theorem
	  ○ Millman's Theorem
	  ○ Reciprocity Theorem
	• Star-Delta and Delta-Star transformations
	• Coupled circuits: Self and mutual inductance, dot convention
	Applications:
	Power distribution networks, transformer equivalent circuits, impedance matching.
		1	25%

II	**Transient Analysis**
	Topics:
	• Introduction to transients in R, L, C circuits
	• Initial and final conditions in circuits
	• DC transients:
	  ○ RL series circuit
	  ○ RC series circuit
	  ○ RLC series circuit (overdamped, underdamped, critically damped)
	• AC transients (qualitative treatment)
	• Laplace transform applications in circuit analysis (introduction)
	Applications: Motor starting, relay operation, surge protection, circuit breakers.
		1	25%

III	**Frequency Response and Resonance** **Topics:** • Frequency response of RLC circuits • Series resonance: Resonance frequency, bandwidth, Q-factor, selectivity • Parallel resonance • Passive filters: ○ Low-pass, High-pass, Band-pass, Band-stop filters • Bode plots (basic concepts) • Introduction to passive network synthesis (LC networks) **Applications:** Tuning circuits, communication systems, filter design, harmonic suppression.	1	25%

IV	**Two-Port Networks and Network Topology**
	Topics:
	• Two-port network parameters:
	  ○ Z-parameters (Impedance)
	  ○ Y-parameters (Admittance)
	  ○ h-parameters (Hybrid)
	  ○ ABCD-parameters (Transmission)
	• Interconnection of two-port networks
	• Network topology:
	  ○ Graph theory: trees, branches, loops, cut-sets
	  ○ Incidence matrix
	  ○ Tie-set and cut-set analysis
	• Introduction to active networks and op-amp circuits (qualitative)
	Applications:
	Amplifier modeling, transformer networks, communication networks, network simulation.
		1	25%

Textbooks:

- Primary: *Network Analysis* – M. E. Van Valkenburg (Pearson)
- Primary: *Electrical Circuit Theory and Technology* – John Bird (Routledge)

Reference books:

- *Fundamentals of Electric Circuits* – Charles K. Alexander & Matthew N. O. Sadiku (McGraw Hill)
- *Engineering Circuit Analysis* – William H. Hayt, Jack E. Kemmerly, Steven M. Durbin (McGraw Hill)
- *Circuit Theory: Analysis and Synthesis* – A. Chakrabarti (Dhanpat Rai)
- *Electric Circuits* – James W. Nilsson & Susan Riedel (Pearson)
- *Network Analysis and Synthesis* – Franklin F. Kuo (Wiley)

Online Platforms:

1. NPTEL:
   - "Network Analysis" by IIT Kharagpur
   - "Circuit Theory" by IIT Madras
2. Coursera:
   - "Linear Circuits" by Georgia Tech
3. edX:
   - "Circuits and Electronics" by MIT

PRACTICAL LIST:

Section A: Advanced Network Theorems

1. Verification of Superposition Theorem for AC circuits
2. Verification of Thevenin's and Norton's Theorems for AC circuits
3. Maximum Power Transfer Theorem for AC circuits
4. Star-Delta and Delta-Star Transformation verification

Section B: Transient Analysis

5. Study of transient response in RC series circuit
6. Study of transient response in RL series circuit
7. Study of RLC series circuit transients (damping observation)
8. Time constant measurement for first-order circuits

Section C: Resonance and Filters

9. Series resonance: Determination of resonance frequency, Q-factor, bandwidth
10. Parallel resonance characteristics
11. Design and testing of Low-pass and High-pass filters
12. Design and testing of Band-pass and Band-stop filters

Section D: Two-Port Networks and Topology

13. Determination of Z-parameters of a two-port network
14. Determination of Y-parameters of a two-port network
15. Verification of interconnection of two-port networks (series, parallel)
16. Simulation of network circuits using software (LTspice / MATLAB-Simulink)

COURSE CODE: DEE203

COURSE NAME: ELECTRONICS-I

Course Objectives:

- To introduce basic semiconductor physics and operation of diodes and transistors.
- To analyze diode and transistor circuits.
- To understand amplifier and oscillator principles.
- To develop skills in designing and testing basic electronic circuits.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the working of PN junction diodes and special diodes.
CO2	Analyze rectifier, filter, and regulator circuits.
C03	Understand the construction and working of BJTs and FETs.
C04	Analyze transistor biasing, amplifier, and oscillator circuits.

Unit	Content	Credit	Weightage
I	**Semiconductor Diodes and Applications** • Semiconductor basics: intrinsic and extrinsic semiconductors, PN junction formation. • PN junction diode: characteristics, forward and reverse bias. • Diode models: ideal and practical. • Special diodes: Zener, LED, photodiode. • Rectifiers: half-wave, full-wave, bridge. • Filters: capacitor filter, ripple factor. • Voltage regulation using Zener diode.	1	25%
II	**Bipolar Junction Transistors (BJTs)** • Construction, working, and characteristics of NPN and PNP transistors. • Transistor configurations: CB, CE, CC; input/output characteristics. • DC biasing: fixed bias, collector-to-base bias, voltage divider bias. • Transistor as a switch and amplifier. • Q-point and stability factors.	1	25%
III	**Field Effect Transistors (FETs)**	1	25%

	• Construction and working of JFET and MOSFET. • Characteristics of JFET: drain and transfer characteristics. • MOSFET: enhancement and depletion types. • FET biasing circuits. • Comparison of BJT and FET.		
IV	**Amplifiers and Oscillators** • Transistor as an amplifier in CE configuration. • Small-signal analysis: hybrid parameters, voltage gain, input/output impedance. • Frequency response of amplifiers. • Feedback concept: positive and negative feedback. • Sinusoidal oscillators: phase shift and Wien bridge oscillators. • Introduction to power amplifiers.	1	25%

Textbooks:

- *Electronic Devices and Circuit Theory* – Robert L. Boylestad & Louis Nashelsky
- *Principles of Electronics* – V.K. Mehta & Rohit Mehta
- *Basic Electronics* – B. L. Theraja

Reference books:

- *Microelectronic Circuits* – A.S. Sedra & K.C. Smith
- *Electronic Principles* – Albert Malvino & David J. Bates
- *Fundamentals of Analog Circuits* – Thomas L. Floyd

Online Platforms:

- NPTEL: *Basic Electronics* by Prof. T.S. Natarajan
- Coursera/edX: Introduction to Electronics

PRACTICAL LIST:

- VI Characteristics of PN Junction Diode & Zener Diode.
- Half-wave and Full-wave Rectifier (with and without filter).
- Zener Diode as Voltage Regulator.
- Input & Output Characteristics of BJT in CE Configuration.
- BJT Biasing Circuits: Fixed Bias and Voltage Divider Bias.
- Drain & Transfer Characteristics of JFET.
- Frequency Response of Common Emitter Amplifier.
- Phase Shift Oscillator using BJT.
- Study of Logic Gates using ICs.
- Soldering Practice and PCB Design for Simple Circuits.

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COURSE CODE: DEE204

COURSE NAME: ELECTRICAL MEASUREMENTS

Course Objectives:

- To introduce fundamental concepts of measurement, errors, and instrument characteristics.
- To explain the working principle and construction of electromechanical and electronic instruments.
- To understand methods for measurement of voltage, current, power, energy, resistance, inductance, and capacitance.
- To develop skills in using measuring instruments and calibration techniques.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the classification, characteristics, and errors in measuring instruments.
CO2	Analyze the working of ammeters, voltmeters, and ohmmeters.
C03	Operate wattmeters, energy meters, and power factor meters for circuit measurements.
C04	Measure circuit parameters (R, L, C) and understand instrument calibration methods.

Unit	Content	Credit	Weightage
I	**Fundamentals of Measurement** • Introduction to measurement: need, significance, and applications. • Classification of instruments: absolute & secondary, analog & digital. • Characteristics of instruments: accuracy, precision, sensitivity, resolution, linearity, hysteresis, repeatability. • Errors in measurement: types (gross, systematic, random), limiting error, error analysis. • Standards: international, primary, secondary, working standards.	1	25%
II	**DC & AC Indicating Instruments** • **Moving coil instruments (PMMC):** construction, working, torque equation, advantages, limitations. • **Ammeters and voltmeters:** extension of range using shunts and multipliers. • **Moving iron instruments:** attraction and repulsion types, errors, advantages. • **Dynamometer type instruments:** construction, principle, use as voltmeter, ammeter, wattmeter. • **Electrostatic voltmeters:** principle and application for HV measurement.	1	25%
III	**Measurement of Power and Energy** • **Single-phase and three-phase power measurement:** dynamometer wattmeter, low power factor wattmeter. • **Three-phase power measurement:** one, two, and	1	25%

	three wattmeter methods (balanced/unbalanced loads). • **Induction type energy meter:** construction, working, driving torque, braking torque, errors, calibration. • **Power factor meters:** dynamometer and moving iron type. • **Frequency meters:** vibrating reed and electrical resonance type.		
IV	**Measurement of Circuit Parameters & Instrument Transformers** • **Measurement of resistance:** low (ammeter-voltmeter, Kelvin double bridge), medium (Wheatstone bridge), high (Megger, loss of charge method). • **Measurement of inductance & capacitance:** Maxwell's bridge, Hay's bridge, Schering bridge, Wien bridge. • **Instrument transformers:** CTs and PTs – construction, ratio, phase angle errors, applications. • **Cathode Ray Oscilloscope (CRO):** block diagram, applications for measurement of voltage, frequency, phase difference. • **Digital instruments:** introduction to DMM, digital frequency meter.	1	25%

Textbooks:

- *Electrical and Electronic Measurements and Instrumentation* – A.K. Sawhney
- *Electrical Measurements and Measuring Instruments* – R.K. Rajput
- *Modern Electronic Instrumentation and Measurement Techniques* – A.D. Helfrick & W.D. Cooper

Reference books:

- *Electronic Instrumentation* – H.S. Kalsi
- *Principles of Measurement and Instrumentation* – A.S. Morris
- *Electrical Measurements: Fundamentals, Concepts, Applications* – Reissland

Online Platforms:

- NPTEL: *Electrical Measurement* by Prof. A. Chattopadhyay

PRACTICAL LIST:

- Study of PMMC and Moving Iron Instruments (Ammeter/Voltmeter).
- Calibration of Ammeter and Voltmeter using Standard Instruments.
- Measurement of Resistance using Wheatstone Bridge.
- Measurement of Low Resistance using Kelvin's Double Bridge.
- Measurement of Earth Resistance using Megger.
- Calibration of Single-Phase Energy Meter.
- Measurement of Power in Single-Phase Circuit using Wattmeter.
- Measurement of Three-Phase Power using Two-Wattmeter Method.
- Measurement of Inductance using Maxwell's Bridge.
- Measurement of Capacitance using Schering Bridge.

- Study of CRO for Measurement of Voltage, Frequency, and Phase Difference.
- Testing of Current Transformer (CT) and Potential Transformer (PT).
- Measurement of Power Factor using Power Factor Meter.
- Use of Digital Multimeter for Various Measurements.

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SEMESTER-III

COURSE CODE: DEE301

COURSE NAME: ELECTRICAL MACHINES-I

Course Objectives:

- To introduce the fundamental principles of electromagnetism as applied to electrical machines.
- To explain the construction, working, and characteristics of DC machines.
- To analyze the performance, testing, and applications of transformers.
- To develop skills in testing, operation, and maintenance of DC machines and transformers.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the laws of electromagnetism and construction of electrical machines.
CO2	Analyze the working, characteristics, and speed control methods of DC motors and generators.
C03	Evaluate the performance, efficiency, and voltage regulation of single-phase and three-phase transformers.
C04	Perform testing, maintenance, and troubleshooting of DC machines and transformers.

Unit	Content	Credit	Weightage
I	**Fundamentals of Electromagnetism & Magnetic Circuits** • Review of electromagnetic laws: Faraday's law, Lenz's law, Fleming's rules. • Magnetic circuits: MMF, reluctance, magnetic field intensity, flux density. • B-H curve, hysteresis, eddy current losses. • Electromechanical energy conversion principle. • Constructional features of electrical machines: yoke, poles, armature, commutator, brushes, windings, insulation.	1	25%
II	**DC Generators** • Construction of DC generator. • Working principle, emf equation. • Types of DC generators: separately excited, shunt, series, compound. • Characteristics of DC generators: open circuit, load, external, internal. • Parallel operation of DC shunt generators. • Applications and losses in DC generators.	1	25%
III	**DC Motors** • Working principle of DC motor, back emf, torque equation. • Types of DC motors: shunt, series, compound – characteristics and applications.	1	25%

	• Speed control methods: armature control, field control. • Starting of DC motors: 3-point and 4-point starters. • Testing of DC machines: Swinburne's test, brake test, Hopkinson's test. • Maintenance and troubleshooting of DC machines.		
IV	**Transformers** • Construction and working principle of single-phase transformer. • EMF equation, transformation ratio, ideal vs practical transformer. • Equivalent circuit, phasor diagram, voltage regulation. • Losses and efficiency, condition for maximum efficiency. • Three-phase transformer: connections (star-star, delta-delta, star-delta), applications. • Testing of transformers: open circuit test, short circuit test, Sumpner's test. • Auto-transformer: construction, working, advantages, applications.	1	25%

Textbooks:

- *Electrical Machines* – D.P. Kothari & I.J. Nagrath
- *A Textbook of Electrical Technology – Vol. II (AC & DC Machines)* – B.L. Theraja & A.K. Theraja
- *Electrical Machinery* – P.S. Bimbhra

Reference books:

- *Theory and Performance of Electrical Machines* – J.B. Gupta
- *Electric Machines* – Charles I. Hubert
- *Electrical Machines, Drives, and Power Systems* – Theodore Wildi

Online Platforms:

- NPTEL: *Electrical Machines I* by Prof. D. Kastha

PRACTICAL LIST:

- Study of Constructional Parts of DC Machine and Transformer.
- Characteristics of DC Shunt Generator: Determination of Critical Resistance and Critical Speed.
- Load Test on DC Shunt Motor: Performance Characteristics.
- Speed Control of DC Shunt Motor by (a) Armature Control (b) Field Control.
- Brake Test on DC Series Motor.
- Swinburne's Test on DC Shunt Machine.
- Open Circuit and Short Circuit Test on Single-Phase Transformer.
- Load Test on Single-Phase Transformer: Determination of Efficiency and Voltage Regulation.
- Sumpner's Test on Two Identical Single-Phase Transformers.
- Study of Three-Phase Transformer Connections (Star-Star, Delta-Delta, Star-Delta).
- Polarity Test and Parallel Operation of Single-Phase Transformers.

- Study of Auto-transformer and Its Load Test.
- Determination of B-H Curve of Magnetic Material.

COURSE CODE: DEE302

COURSE NAME: POWER SYSTEMS-I

Course Objectives:

- To introduce the structure and components of a modern power system.
- To analyze the performance of overhead transmission lines and underground cables.
- To understand distribution systems, substations, and protective equipment.
- To develop skills in basic power system calculations and practical testing.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the layout, components, and operation of a power system.
CO2	Analyze the performance of short, medium, and long transmission lines.
C03	Select appropriate cables, insulators, and protective devices for distribution systems.
C04	Interpret substation layouts, earthing systems, and voltage control methods.

Unit	Content	Credit	Weightage
I	**Introduction to Power Systems** • Structure of a power system: generation, transmission, distribution. • Types of power stations: thermal, hydro, nuclear, solar, wind (brief overview). • Single line diagram (SLD) symbols and representation. • Standard voltage levels: LV, MV, HV, EHV. • Advantages of interconnected systems. • Introduction to load curves, load factor, diversity factor, demand factor.	1	25%
II	**Overhead Transmission Lines** • Line parameters: resistance, inductance, capacitance (concepts only, no extensive derivations). • Types of conductors: AAC, AAAC, ACSR, bundled conductors. • Types of supports: wooden, RCC, steel towers. • Insulators: pin type, suspension, strain, shackle insulators. • Corona: phenomenon, factors affecting corona, advantages/disadvantages. • Sag and tension calculations: effect of wind, ice loading.	1	25%

III	**Performance of Transmission Lines** • Classification of lines: short (<80 km), medium (80–240 km), long (>240 km). • Representation of short lines: ABCD parameters. • Medium lines: nominal-T and nominal-π representations. • Voltage regulation and efficiency calculations. • Introduction to Ferranti effect in long lines. • Surge impedance loading (SIL).	1	25%
IV	**Distribution Systems & Substations** • Types of distribution systems: radial, ring main, interconnected. • AC vs DC distribution, underground cables: construction and types (LT & HT). • Substations: classification (indoor, outdoor), key equipment (isolators, CTs, PTs, circuit breakers, lightning arresters). • Earthing systems: equipment earthing, system neutral earthing. • Voltage control: tap-changing transformers, shunt capacitors. • Introduction to HVDC transmission (advantages only).	1	25%

Textbooks:

- *Power System Engineering* – I.J. Nagrath & D.P. Kothari
- *A Course in Power Systems* – J.B. Gupta
- *Electrical Power Systems* – C.L. Wadhwa

Reference books:

- *Modern Power System Analysis* – D.P. Kothari & I.J. Nagrath
- *Electrical Power Distribution Systems* – V. Kamaraju
- *Power System Protection and Switchgear* – B. Ram & D.N. Vishwakarma

Online Platforms:

- NPTEL: *Power System Generation, Transmission and Distribution* by Prof. D.P. Kothari

PRACTICAL LIST:

- Study of Single Line Diagram (SLD) of a Typical Power System.
- Determination of Breakdown Strength of Insulating Oil.
- Study of Different Types of Insulators (Pin, Suspension, Strain) and Their Testing.
- Measurement of Sag in Overhead Line Model.
- Study of ACSR Conductors and Measurement of Resistance per km.
- Performance of Short Transmission Line Model: Measurement of Voltage Regulation.
- Study of Different Types of Underground Cables (PVC, XLPE) and Their Construction.
- Study of Substation Layouts (33/11 kV, 11/0.4 kV) Using Models/Charts.
- Earthing Resistance Measurement Using Megger/Earth Tester.
- Study of Lightning Arrester and Its Characteristics.
- Load Flow Analysis on a Simple 3-Bus System Using Software (ETAP/PowerWorld).
- Study of Corona Effect Demonstration Setup.

- Calculation of Line Parameters for a Given Transmission Line Configuration.

COURSE CODE: DEE303

COURSE NAME: DIGITAL ELECTRONICS

Course Objectives:

- To introduce fundamental concepts of digital systems, binary arithmetic, and logic gates.
- To analyze and simplify Boolean functions using algebraic and K-map techniques.
- To design and implement combinational and sequential logic circuits.
- To develop skills in working with digital ICs, flip-flops, counters, and registers.

Course Outcomes: At the end of the course students shall be able to

CO1	Convert number systems, apply Boolean algebra, and implement logic gates.
CO2	Simplify logic expressions and design combinational circuits (adders, multiplexers, encoders).
C03	Analyze and design sequential circuits using flip-flops, counters, and registers.
C04	Interface digital circuits with basic real-world applications.

Unit	Content	Credit	Weightage
I	**Number Systems & Logic Gates** • Number systems: binary, octal, hexadecimal, conversions. • Binary arithmetic: addition, subtraction (1's and 2's complement), multiplication. • Logic gates: AND, OR, NOT, NAND, NOR, XOR, XNOR – truth tables, symbols, ICs. • Boolean algebra: laws, De Morgan's theorem. • Logic families: TTL and CMOS characteristics, comparison.	1	25%
II	**Combinational Logic Design** • Canonical forms: SOP and POS. • Karnaugh map (up to 4 variables) – simplification of Boolean functions. • Arithmetic circuits: half adder, full adder, half subtractor, full subtractor. • Multiplexers and demultiplexers (4:1, 8:1). • Encoders and decoders (binary to decimal, BCD to 7-segment). • Parity generators and checkers.	1	25%
III	**Sequential Logic Fundamentals** • Latches: SR latch. • Flip-flops: SR, JK, D, T – truth tables, excitation tables, race-around condition in JK FF. • Master-slave JK flip-flop. • Registers: SISO, SIPO, PISO, PIPO, shift registers (bidirectional).	1	25%

	• Counters: asynchronous (ripple) counters, synchronous counters, up/down counters.		
IV	**Advanced Sequential Circuits & Applications** • Mod-N counters, design using flip-flops. • Ring counter, Johnson counter. • Introduction to finite state machines (Mealy and Moore models). • Memory devices: ROM, RAM (basic concepts). • Introduction to PLDs: PROM, PAL, PLA (basic block diagrams only). • Simple digital applications: digital clock, traffic light control (concept only).	1	25%

Textbooks:

- *Digital Logic and Computer Design* – M. Morris Mano
- *Modern Digital Electronics* – R.P. Jain
- *Digital Electronics* – S. Salivahanan & S. Arivazhagan

Reference books:

- *Fundamentals of Digital Circuits* – A. Anand Kumar
- *Digital Design* – M. Morris Mano & Michael D. Ciletti
- *Digital Systems: Principles and Applications* – Ronald J. Tocci

Online Platforms:

- NPTEL: *Digital Circuits* by Prof. S. Srinivasan

PRACTICAL LIST:

- Verification of Truth Tables of Basic and Universal Logic Gates.
- Implementation of Boolean Functions Using Logic Gates.
- Design and Verification of Half/Full Adder and Subtractor Circuits.
- Design and Testing of 4-bit Parity Generator/Checker.
- Implementation and Testing of Multiplexer (4:1) and Demultiplexer (1:4).
- Design and Testing of Encoder (8:3) and Decoder (3:8).
- Study and Testing of Flip-Flops (SR, JK, D, T).
- Design and Testing of 4-bit Shift Register (SISO, SIPO).
- Design and Testing of Asynchronous (Ripple) Up/Down Counter.
- Design and Testing of Synchronous Mod-10 Counter.
- Interfacing BCD to 7-Segment Decoder and Display.
- Simulation of Digital Circuits Using Software (Logisim/Proteus).
- Mini-Project: Simple Digital Clock/Traffic Light Controller.

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SEMESTER-IV

COURSE CODE: DEE401

COURSE NAME: ELECTRICAL MACHINES-II

Course Objectives:

- To explain the construction, working, and performance of three-phase induction motors.
- To analyze single-phase induction motors, synchronous machines, and special machines.
- To understand starting, speed control, and testing methods for AC machines.
- To develop skills in operation, maintenance, and troubleshooting of industrial AC machines.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the working principle, construction, and types of three-phase induction motors.
CO2	Analyze performance characteristics, starting, and speed control methods of induction motors.
C03	Understand the operation and applications of synchronous generators and motors.
C04	Identify the working principles and applications of single-phase motors and special machines.

Unit	Content	Credit	Weightage
I	**Three-Phase Induction Motors** • Construction: squirrel cage and slip-ring types. • Rotating magnetic field principle, slip, frequency of rotor currents. • Torque equation, torque-slip characteristics. • Power flow diagram, losses, and efficiency. • Starting methods: DOL, star-delta, autotransformer, rotor resistance starting. • Speed control methods: pole changing, supply frequency, rotor resistance, cascade control.	1	25%
II	**Testing, Performance & Maintenance of Induction Motors** • No-load and blocked rotor tests. • Circle diagram: construction and performance prediction. • Cogging and crawling phenomena. • Induction generator: principle and applications. • Maintenance: bearing maintenance, insulation testing, vibration analysis. • Troubleshooting common faults (overheating, single phasing, unbalanced supply).	1	25%
III	**Single-Phase Induction Motors & Special Machines** • Double revolving field theory. • Types: split-phase, capacitor-start, capacitor-run, capacitor-start-capacitor-run, shaded-pole motors.	1	25%

	• Universal motor, repulsion motor, AC series motor. • Stepper motors: types (VR, PM, hybrid), driving circuits. • Brushless DC motor (BLDC) – basic concept and applications. • Servo motors: AC and DC servo motors.		
IV	**Synchronous Machines** • Construction of synchronous generator (alternator). • EMF equation, armature reaction, voltage regulation. • Synchronous impedance method for voltage regulation. • Parallel operation of alternators: synchronizing methods. • Synchronous motor: principle, starting methods, V-curves, power factor correction. • Applications of synchronous machines in industry.	1	25%

Textbooks:

- *Electrical Machinery* – P.S. Bimbhra
- *A Textbook of Electrical Technology – Vol. II (AC & DC Machines)* – B.L. Theraja & A.K. Theraja
- *Electrical Machines* – D.P. Kothari & I.J. Nagrath

Reference books:

- *Performance and Design of AC Machines* – M.G. Say
- *Alternating Current Machines* – A.E. Fitzgerald & Charles Kingsley Jr.
- *Electric Motors and Drives* – Austin Hughes

Online Platforms:

- NPTEL: *Electrical Machines II* by Prof. D. Kastha

PRACTICAL LIST:

- Study of Construction of Squirrel Cage and Slip-Ring Induction Motors.
- No-Load and Blocked Rotor Test on Three-Phase Induction Motor.
- Load Test on Three-Phase Induction Motor to Draw Performance Characteristics.
- Speed Control of Three-Phase Induction Motor by (a) V/f Method (b) Rotor Resistance Control.
- Study of Starting Methods: Star-Delta Starter and DOL Starter.
- Separation of Losses in Three-Phase Induction Motor.
- Study of Single-Phase Induction Motor: Capacitor-Start and Capacitor-Run Types.
- Load Test on Single-Phase Induction Motor.
- Study of Synchronous Generator: Determination of Voltage Regulation by Synchronous Impedance Method.
- Study of V-Curves and Inverted V-Curves of Synchronous Motor.
- Study of Stepper Motor: Step Angle Calculation and Driving Circuit.
- Troubleshooting Common Faults in Induction Motors.
- Demonstration of Servo Motor Operation and Control.

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COURSE CODE: DEE402

COURSE NAME: POWER SYSTEMS-II

Course Objectives:

- To analyze power system faults and their effects on system stability.
- To explain protective relaying schemes and switchgear operation.
- To introduce economic operation, load dispatch, and power factor improvement.
- To develop skills in fault analysis, relay testing, and system protection coordination.

Course Outcomes: At the end of the course students shall be able to

CO1	Analyze symmetrical and unsymmetrical faults using symmetrical components.
CO2	Select and coordinate protective relays for generators, transformers, and feeders.
C03	Understand power system stability, economic load dispatch, and tariff structures.
C04	Design earthing systems, calculate lightning protection, and improve power factor.

Unit	Content	Credit	Weightage
I	**Fault Analysis & Symmetrical Components** • Causes and consequences of faults in power systems. • Symmetrical (balanced) faults: calculation of fault current using Thevenin's theorem. • Per-unit system: advantages and calculations. • Symmetrical components: positive, negative, and zero sequence networks. • Unsymmetrical faults: LG, LL, LLG faults (concepts only). • Introduction to fault limiting devices: fuses, current-limiting reactors.	1	25%
II	**Power System Protection** • Protective relaying: basic principles, zones of protection. • Relay classification: electromagnetic, static, numerical. • Overcurrent relays: IDMT characteristics, time-grading. • Differential protection: transformer and generator protection. • Distance relays: principle and applications for transmission lines. • Circuit breakers: types (oil, vacuum, SF6), arc interruption, ratings.	1	25%
III	**Power System Stability & Economic Operation**	1	25%

	• Stability concepts: steady-state, transient, and dynamic stability. • Swing equation, equal area criterion (concept only). • Methods to improve stability: fast circuit breakers, auto-reclosing. • Economic operation: load curves, load forecasting. • Economic load dispatch (neglecting losses). • Tariffs: simple, two-part, three-part tariffs, power factor tariffs.		
IV	**System Earthing, Lightning Protection & Power Quality** • Neutral grounding: solid, resistance, Peterson coil grounding. • Equipment earthing: plate and pipe earthing, earth resistance measurement. • Lightning protection: lightning arrestors (rod gap, valve type), surge diverters. • Power factor improvement: causes of low PF, capacitor bank calculation. • Harmonics: basic concepts, effects, and mitigation. • Introduction to SCADA and smart grid concepts.	1	25%

Textbooks:

- *Power System Protection and Switchgear* – B. Ram & D.N. Vishwakarma
- *Power System Engineering* – I.J. Nagrath & D.P. Kothari
- *A Course in Power Systems* – J.B. Gupta

Reference books:

- *Power System Analysis* – Hadi Saadat
- *Electrical Power Systems* – C.L. Wadhwa
- *Power System Protection* – Paithankar and Bhide

Online Platforms:

- NPTEL: *Power System Protection* by Prof. Bhavesh Bhalja

PRACTICAL LIST:

- Study of Different Types of Fuses (HRC, Cartridge, Drop-out).
- Characteristics of IDMT Overcurrent Relay Using Relay Test Kit.
- Simulation of Symmetrical Fault (3-Phase) Using Software (MATLAB/ETAP).
- Study of Buchholz Relay and Transformer Differential Protection.
- Testing of Oil and Vacuum Circuit Breaker (Operating Mechanism).
- Coordination of Overcurrent Relays Using Time-Current Characteristic Curves.
- Measurement of Earth Resistance Using Megger/Earth Tester.
- Calculation of Capacitor Bank Rating for Power Factor Improvement.
- Study of Lightning Arrester and Surge Diverters.
- Load Duration Curve Analysis and Tariff Calculation.
- Simulation of LG Fault Using Symmetrical Components (Software).
- Study of Numerical Relay and Its Settings.
- Mini-Project: Design of Protection Scheme for a 11 kV Feeder.

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COURSE CODE: DEE403

COURSE NAME: MICROPROCESSORS AND APPLICATIONS

Course Objectives:

- To introduce the architecture and organization of microprocessors and microcontrollers.
- To develop skills in assembly language programming for problem-solving.
- To understand interfacing techniques for peripherals and real-world applications.
- To introduce modern embedded systems and their applications in electrical engineering.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the architecture and pin configuration of 8085 and 8051.
CO2	Write assembly language programs for arithmetic, logic, and I/O operations.
C03	Interface memory, ADC, DAC, stepper motors, and displays with microprocessors.
C04	Apply microprocessor knowledge to industrial control, instrumentation, and automation systems.

Unit	Content	Credit	Weightage
I	**Introduction to Microprocessors and 8085 Architecture** • Evolution of microprocessors, microprocessor vs microcontroller. • 8085 architecture: ALU, registers, flags, pin diagram, bus structure. • Addressing modes: immediate, direct, indirect, register, implicit. • Instruction set: data transfer, arithmetic, logical, branching, machine control. • Memory organization: RAM, ROM, memory mapping, interfacing.	1	25%
II	**8085 Programming and Interrupts** • Assembly language programming: instruction format, assembler directives. • Programming techniques: loops, counters, time delays, subroutines. • Stack and stack pointer operations. • Interrupts in 8085: hardware and software interrupts, interrupt priorities, RST instructions. • Interfacing I/O devices: memory-mapped I/O vs I/O-mapped I/O.	1	25%
III	**Introduction to 8051 Microcontroller** • 8051 architectures: CPU, registers, memory organization (internal RAM, SFRs). • 8051 pin diagram, I/O ports, timers/counters. • 8051 instruction set and addressing modes. • Simple programming examples: data transfer,	1	25%

	arithmetic operations, bit manipulation. • Interrupt structure in 8051.		
IV	**Interfacing and Applications** • Interfacing with 8085/8051: o Memory interfacing (RAM, ROM). o ADC and DAC interfacing (0808/0809, 0800). o Stepper motor and DC motor interfacing. o 7-segment display, LCD interfacing. • Introduction to embedded systems: basic structure and examples. • Applications in electrical engineering: digital protection relays, smart meters, temperature control systems.	1	25%

Textbooks:

- *Microprocessor Architecture, Programming, and Applications with the 8085* – Ramesh Gaonkar
- *The 8051 Microcontroller and Embedded Systems* – Muhammad Ali Mazidi
- *Microprocessors and Interfacing* – Douglas V. Hall

Reference books:

- *Fundamentals of Microprocessors and Microcontrollers* – B. Ram
- *Microcontrollers: Theory and Applications* – Ajay Deshmukh
- *Embedded Systems* – Raj Kamal

Online Platforms:

- NPTEL:
  1. *Microprocessors and Microcontrollers* by Prof. Santanu Chattopadhyay
  2. *Embedded Systems* by Prof. Indranil Sengupta

COURSE CODE: DEE404

COURSE NAME: RENEWABLE ENERGY SYSTEMS

Course Objectives:

- To introduce the fundamental principles and technologies of renewable energy resources.
- To analyze the design, operation, and grid integration of solar and wind energy systems.
- To understand emerging renewable technologies and energy storage systems.
- To evaluate the economic, environmental, and policy aspects of renewable energy deployment.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the principles, potential, and applications of major renewable energy sources.
CO2	Analyze the design and performance of solar PV systems and wind energy conversion systems.
C03	Understand the operation, integration, and storage requirements for renewable energy systems.
C04	Evaluate the economic feasibility and environmental impact of renewable energy projects.

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Unit	Content	Credit	Weightage
I	**Introduction to Renewable Energy** • Energy scenario: global and national, fossil fuel limitations. • Renewable energy sources: solar, wind, biomass, hydro, geothermal, ocean energy – overview and potential. • Environmental benefits and challenges of renewable energy. • Basic energy concepts: energy units, capacity factor, load factor, diversity factor. • Government policies and initiatives (national and state-level).	1	25%
II	**Solar Energy Systems** • Solar radiation: measurement, solar geometry, irradiation data. • Solar photovoltaic (PV): working principle of solar cells, types of PV cells (mono, poly, thin-film). • PV system components: modules, arrays, charge controllers, inverters, batteries. • Types of PV systems: stand-alone, grid-connected, hybrid systems. • Design of solar PV systems for domestic and street lighting. • Solar thermal systems: flat plate collectors, concentrating collectors, applications.	1	25%
III	**Wind Energy Systems** • Wind energy principles: power in wind, Betz limit, site selection. • Wind turbine components: rotor, gearbox, generator, tower, control systems. • Types of wind turbines: horizontal axis (HAWT) and vertical axis (VAWT). • Wind energy conversion systems (WECS): fixed speed and variable speed systems. • Grid integration of wind power: power quality issues, grid codes. • Small-scale wind turbines for rural applications.	1	25%
IV	**Emerging Technologies & System Integration** • **Biomass energy:** conversion technologies (combustion, gasification, biogas). • **Small hydropower:** classification, components, micro-hydel plants. • **Energy storage:** batteries (lead-acid, lithium-ion), pumped hydro, flywheels, supercapacitors. • **Grid integration challenges:** variability, intermittency, smart grid role.	1	25%

	• **Hybrid systems:** solar-wind, solar-diesel, mini-grids. • **Economic analysis:** cost of energy, payback period, incentives.		

Textbooks:

- *Renewable Energy Sources* – G. D. Rai
- *Non-Conventional Energy Resources* – B. H. Khan
- *Solar Photovoltaics: Fundamentals, Technologies and Applications* – Chetan Singh Solanki

Reference books:

- *Wind and Solar Power Systems* – Mukund R. Patel
- *Renewable Energy Engineering* – Nick Jenkins
- *Principles of Solar Engineering* – D. Y. Goswami

Online Platforms:

- NPTEL:
  1. *Renewable Energy Engineering: Solar & Wind* by Prof. S. Banerjee
  2. *Solar Energy* by Prof. D. P. Kothari

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SEMESTER-V

COURSE CODE: DEE501

COURSE NAME: CONTROL SYSTEMS

Course Objectives:

- To introduce fundamental concepts of control systems, modeling, and analysis.
- To analyze system response using time-domain and frequency-domain methods.
- To understand stability criteria and controller design for feedback systems.
- To develop skills in simulating and testing control systems practically.

Course Outcomes: At the end of the course students shall be able to

CO1	Model physical systems and derive transfer functions using block diagrams and signal flow graphs.
CO2	Analyze time response (transient and steady-state) of first and second-order systems.
C03	Assess stability using Routh-Hurwitz, Bode, and Nyquist criteria.
C04	Design basic P, PI, and PID controllers and simulate control systems using software.

Unit	Content	Credit	Weightage
I	**Introduction to Control Systems** • Basic concepts: open-loop vs closed-loop systems, examples from daily life and industry. • Mathematical modeling: differential equations of physical systems (electrical, mechanical). • Transfer function: definition, poles, zeros. • Block diagram algebra: reduction rules, simplification. • Signal flow graphs: Mason's gain formula (basic applications).	1	25%
II	**Time-Domain Analysis** • Standard test signals: step, ramp, parabolic, impulse. • Time response analysis: transient and steady-state response. • First-order systems: step response, time constant. • Second-order systems: step response, damping ratio, natural frequency, peak time, overshoot, settling time. • Steady-state error and error constants (Kp, Kv, Ka).	1	25%
III	**Stability Analysis** • Concept of stability: bounded-input bounded-output (BIBO) stability. • Routh-Hurwitz stability criterion. • Root locus: construction rules, interpretation for	1	25%

	stability analysis. • Frequency response analysis: Bode plot (magnitude and phase plots), gain margin, phase margin. • Nyquist stability criterion (basic concept only).		
IV	**Controllers & Compensation Techniques** • Need for compensation. • Types of controllers: P, PI, PD, PID – characteristics and effects on system response. • Basic compensation techniques: lag, lead, lag-lead compensators (concepts only). • Introduction to state-space representation (concept only). • Introduction to digital control systems: basic block diagram of digital control.	1	25%

Textbooks:

- *Control Systems Engineering* – I.J. Nagrath & M. Gopal
- *Automatic Control Systems* – Benjamin C. Kuo
- *Modern Control Engineering* – Katsuhiko Ogata

Reference books:

- *Control Systems: Principles and Design* – M. Gopal
- *Control System Engineering* – Norman S. Nise
- *Problems & Solutions in Control System Engineering* – S. Palani

Online Platforms:

- NPTEL:
  1. *Control Engineering* by Prof. S. D. Agashe
  2. *Control Systems* by Prof. Ramkrishna Pasumarthy

PRACTICAL LSIT:

- Study of Open-Loop and Closed-Loop Control Systems (using temperature/fan speed control kit).
- Time Response of First-Order System (RC circuit) to Step Input.
- Time Response of Second-Order System (RLC circuit) and Determination of Damping Ratio.
- Study of DC Position Control System.
- Simulation of Transfer Function and Step Response using MATLAB/Scilab.
- Stability Analysis using Routh-Hurwitz Criterion (numerical verification via software).
- Construction of Root Locus for a Given System using Software.
- Plotting Bode Plot for a Given Transfer Function and Determination of Gain & Phase Margins.
- Study of P, PI, and PID Controllers using MATLAB/Simulink.
- Speed Control of DC Motor using PID Controller (simulation/hardware demo).
- Design of Lead Compensator for a Given System.
- Study of Temperature Control System (on-off control).
- Mini-Project: Water Level Control System using Feedback.

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COURSE CODE: DEE502

COURSE NAME: ELECTRICAL DRIVES

Course Objectives:

- To introduce fundamental concepts, components, and characteristics of electric drives.
- To analyze the operation, control, and performance of DC and AC motor drives.
- To understand power electronic converters used in drive systems.
- To study industrial applications, selection criteria, and protection of electric drives.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the basic elements, characteristics, and dynamics of electric drive systems.
CO2	Analyze the speed control methods of DC drives using controlled rectifiers and choppers.
C03	Explain the operation of AC drives using inverters, V/f control, and vector control concepts.
C04	Select appropriate drives for industrial applications and understand drive protection.

Unit	Content	Credit	Weightage
I	**Fundamentals of Electric Drives** • Definition, advantages, and applications of electric drives. • Basic structure: power source, power converter, motor, load, controller, sensors. • Types of loads: constant torque, variable torque, constant power. • Four-quadrant operation of drives. • Dynamics of electric drives: fundamental torque equations, speed-torque characteristics. • Selection of motor power rating: thermal rating, duty cycles (continuous, intermittent).	1	25%
II	**DC Motor Drives** • Speed control of DC motors: armature voltage control, field flux control. • Single-phase and three-phase controlled rectifier fed DC drives: waveforms, operation. • DC-DC converter (chopper) fed DC drives: principle, quadrant operation. • Closed-loop control of DC drives: speed control with inner current loop. • Starting and braking of DC drives: dynamic braking, regenerative braking. • Applications: traction, rolling mills, cranes.	1	25%
III	**AC Motor Drives** • Need for variable speed AC drives.	1	25%

	• Induction motor drives: speed control methods – stator voltage control, V/f control, rotor resistance control. • Variable frequency drives (VFD): voltage source inverter (VSI) based drives, PWM techniques. • Introduction to vector control (field-oriented control) – basic concept. • Synchronous motor drives: brushless DC (BLDC) and permanent magnet synchronous motor (PMSM) drives – overview. • Applications: pumps, fans, compressors, conveyor systems.		
IV	**Drive Converters & Industrial Applications** • Power electronic converters for drives: AC-DC, DC-DC, DC-AC, AC-AC (cycloconverter – concept only). • Drive protection: overcurrent, overvoltage, overload, thermal protection. • Energy efficiency in drives: importance, standards (IE classes). • Selection of drives for specific applications (case studies: centrifugal pump, elevator, CNC machine). • Introduction to modern trends: smart drives, IoT in drives, regenerative drives.	1	25%

Textbooks:

- *Fundamentals of Electric Drives* – G. K. Dubey
- *Power Electronics and Drives* – Vedam Subrahmanyam
- *A First Course on Electrical Drives* – S. K. Pillai

Reference books:

- *Electric Drives* – N. K. De & Prashant K. Sen
- *Electric Motor Drives: Modeling, Analysis and Control* – R. Krishnan
- *Power Electronics: Converters, Applications, and Design* – Ned Mohan, Tore M. Undeland, William P. Robbins

Online Platforms:

- NPTEL:
  1. *Electric Drives* by Prof. S. K. Panda
  2. *Power Electronics* by Prof. G. Bhuvaneshwari

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COURSE CODE: DEE503

COURSE NAME: POWER ELECTRONICS

Course Objectives:

- To introduce the working principles and characteristics of power semiconductor devices.
- To analyze the operation and applications of AC-DC, DC-DC, DC-AC, and AC-AC converters.
- To understand the role of power electronics in motor drives, power supplies, and renewable energy systems.
- To develop skills in designing, simulating, and testing basic power electronic circuits.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the construction, characteristics, and triggering methods of power devices.
CO2	Analyze the operation of controlled rectifiers, choppers, and inverters.
C03	Design basic power electronic circuits for voltage control and frequency conversion.
C04	Interface power electronic converters with practical loads and protective circuits.

Unit	Content	Credit	Weightage
I	**Power Semiconductor Devices** • Introduction to power electronics and its applications. • Power diodes: characteristics, reverse recovery, types. • Thyristors (SCR): construction, V-I characteristics, two-transistor model. • Thyristor triggering methods: R, RC, UJT triggering circuits. • Commutation techniques: natural and forced commutation. • Other devices: TRIAC, DIAC, GTO, MOSFET, IGBT – basic operation and comparison.	1	25%
II	**AC to DC Converters (Controlled Rectifiers)** • Phase-controlled rectifiers: principle of phase control. • Single-phase half-wave-controlled rectifier with R and RL load. • Single-phase full-wave controlled rectifier: midpoint and bridge configurations. • Three-phase half-wave and full-wave controlled rectifiers (concept only). • Effect of freewheeling diode. • Input power factor and harmonics introduction.	1	25%
III	**DC to DC Converters (Choppers) & DC to AC**	1	25%

	Converters (Inverters) • **Choppers:** principle, classification (step-down, step-up). • Switching regulators: buck, boost, buck-boost converters (operation and waveforms). • **Inverters:** need for inversion, classification. • Single-phase bridge inverters: square wave operation, concept of PWM. • Three-phase inverters: 180° and 120° conduction modes (basic idea). • Voltage control methods for inverters: single PWM, multiple PWM.		

IV	**AC to AC Converters & Applications**
	• AC voltage controllers: single-phase TRIAC-based dimmer circuit.
	• Cycloconverters: basic principle and applications (concept only).
	• **Applications:**
	  ○ SMPS: block diagram and principle.
	  ○ UPS: types (online, offline), block diagram.
	  ○ Induction heating and welding introduction.
	• Snubber circuits: need and design.
	• Cooling and heat sinks for power devices.
		1	25%

Textbooks:

- *Power Electronics* – P. S. Bimbhra
- *Power Electronics: Converters, Applications, and Design* – Ned Mohan, Tore M. Undeland, William P. Robbins
- *Power Electronics* – M. D. Singh & K. B. Khanchandani

Reference books:

- *Power Electronics* – M. H. Rashid
- *Thyristors and their Applications* – M. Ramamoorty
- *Fundamentals of Power Electronics* – Robert W. Erickson & Dragan Maksimović

Online Platforms:

- NPTEL:
  1. *Power Electronics* by Prof. G. Bhuvaneshwari
  2. *Power Electronics* by Prof. L. Umanand

PRACTICAL LIST:

- V-I Characteristics of SCR and TRIAC.
- UJT Triggering Circuit for SCR.
- Study of DIAC-TRIAC based AC Voltage Controller (Fan Dimmer).
- Single-Phase Half-Wave Controlled Rectifier with R and RL Load.
- Single-Phase Full-Wave Controlled Rectifier using SCRs.
- Step-Down DC Chopper (Buck Converter) using MOSFET/IGBT.
- Step-Up DC Chopper (Boost Converter) using MOSFET/IGBT.
- Single-Phase Bridge Inverter (Square Wave Output) using MOSFETs/IGBTs.
- PWM Inverter using IC SG3525/IR2110.

- Study of SMPS (Switched Mode Power Supply) Block Diagram and Testing.
- Study of UPS (Uninterruptible Power Supply) Operation.
- Simulation of Three-Phase Inverter using Software (MATLAB/PSIM).
- Mini-Project: Design of a Battery Charger using Controlled Rectifier.

COURSE CODE: DEE504

COURSE NAME: SMART GRID AND IOT

Course Objectives:

- To introduce the concepts, architecture, and components of a smart grid.
- To explain the role of IoT, communication, and data management in smart grids.
- To analyze smart grid technologies like AMI, demand response, and renewable integration.
- To understand cybersecurity, standards, and future trends in smart electrical systems.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the need, components, and benefits of smart grid over conventional grid.
CO2	Describe IoT architecture and communication protocols used in smart grid applications.
C03	Analyze smart metering, demand-side management, and distributed generation integration.
C04	Identify cybersecurity challenges and standards in smart grid implementation.

Unit	Content	Credit	Weightage
I	**Introduction to Smart Grid** • Evolution of power grids: conventional vs smart grid. • Definitions, objectives, and benefits of smart grid. • Key components: smart meters, sensors, PMU, ICT infrastructure. • Smart grid architecture: conceptual model, layers (physical, communication, application). • Challenges in smart grid implementation. • Global and Indian smart grid initiatives.	1	25%
II	**IoT Fundamentals for Smart Grid** • IoT definition, architecture (sensing, network, application layers). • IoT devices: sensors, actuators, embedded systems. • Communication technologies: Zigbee, Wi-Fi, LoRaWAN, PLC, RFID, cellular (4G/5G). • Data acquisition and processing: cloud vs edge computing. • IoT protocols: MQTT, CoAP, HTTP. • Role of IoT in grid monitoring, fault detection, and asset management.	1	25%

III	**Smart Grid Technologies & Applications** • **Advanced Metering Infrastructure (AMI):** smart meters, two-way communication, TOU pricing. • **Demand Response (DR):** concepts, direct load control, pricing signals. • **Renewable Integration:** microgrids, virtual power plants, energy storage integration. • **Distribution Automation:** fault location, isolation, service restoration (FLISR). • **Wide Area Monitoring Systems (WAMS):** PMU, SCADA, real-time grid monitoring. • **Electric Vehicles (EVs):** V2G (vehicle-to-grid) technology.	1	25%
IV	**Cybersecurity, Standards & Future Trends** • Cybersecurity threats in smart grid: data theft, false data injection, DoS attacks. • Security measures: encryption, authentication, firewall, intrusion detection. • Standards: IEEE 1547, IEC 61850, NIST framework. • Big data and analytics in smart grid. • Future trends: AI/ML in grid optimization, blockchain for energy trading, digital twins. • Case studies: Indian smart grid projects (e.g., NDPL, Bangalore solar).	1	25%

Textbooks:

- *Smart Grid: Fundamentals of Design and Analysis* – James Momoh
- *The Internet of Things: Enabling Technologies and Applications* – Pethuru Raj & Anupama C. Raman
- *Smart Grid: Technology and Applications* – Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins

Reference books:

- *Smart Grids: Infrastructure, Technology, and Solutions* – Stuart Borlase
- *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things* – David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry
- *Smart Grid Handbook* – Liu, McArthur, Lee

Online Platforms:

- NPTEL:
  1. *Smart Grid* by Prof. N. P. Padhy
  2. *Internet of Things* by Prof. Sudip Misra

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SEMESTER-VI

COURSE CODE: DEE601

COURSE NAME: SWITCH GEAR AND PROTECTION

Course Objectives:

- To introduce the principles of power system protection and switchgear operation.
- To analyze the construction, operation, and application of protective relays and circuit breakers.
- To understand protection schemes for generators, transformers, feeders, and busbars.
- To develop skills in testing, coordination, and maintenance of protection systems.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the need for protection, protection zones, and relay characteristics.
CO2	Select and apply appropriate relays for overcurrent, differential, and distance protection.
C03	Analyze the operation and ratings of different types of circuit breakers and fuses.
C04	Design basic protection schemes for electrical equipment and interpret coordination curves.

Unit	Content	Credit	Weightage
I	**Fundamentals of Protection Systems** • Need for protective systems, primary and backup protection. • Zones of protection, selectivity, sensitivity, reliability, speed. • Basic relay terminology: pick-up, reset, operating time, plug setting multiplier (PSM), time multiplier setting (TMS). • Current transformers (CTs) and voltage transformers (PTs): construction, ratio, errors, burden, connections. • Types of relays: electromagnetic, static, numerical, microprocessor-based.	1	25%
II	**Protective Relays & Characteristics** • **Overcurrent relays:** instantaneous, definite time, inverse definite minimum time (IDMT) – characteristics and applications. • **Directional relays:** principle, construction, applications in parallel feeders and ring mains. • **Differential protection:** principle, percentage differential relay for transformer and generator protection.	1	25%

	• **Distance relays:** impedance, reactance, mho relays – basic principle and applications for transmission lines. • **Pilot wire protection:** principle of transfer tripping.		

III	**Circuit Breakers & Fuses**
	• Arc phenomena: initiation, maintenance, and extinction of arc.
	• **Circuit breakers:**
	  ○ Oil circuit breakers (OCB): bulk oil and minimum oil types.
	  ○ Air-blast circuit breakers (ABCB).
	  ○ SF_6 circuit breakers.
	  ○ Vacuum circuit breakers (VCB).
	• Operating mechanisms: solenoid, spring, pneumatic, hydraulic.
	• **Fuses:** types (HRC, cartridge, drop-out), characteristics, selection.
	• Ratings: breaking capacity, making capacity, short-time rating.
		1	25%

IV	**Protection of System Components** • **Generator protection:** stator faults (differential, overcurrent), rotor faults (field failure), negative sequence, reverse power protection. • **Transformer protection:** Buchholz relay, differential, overcurrent, restricted earth fault (REF) protection. • **Feeder protection:** overcurrent, distance, carrier current protection. • **Busbar protection:** frame leakage, differential protection. • **Motor protection:** overcurrent, single phasing, under-voltage, thermal overload protection. • Introduction to numerical relays and IEC 61850 standard.	1	25%

Textbooks:

- Power System Protection and Switchgear – B. Ram & D.N. Vishwakarma
- Switchgear and Protection – Sunil S. Rao
- A Course in Electrical Power – S.L. Uppal & S. Rao

Reference books:

- *Protective Relays: Their Theory and Practice* – A.R. van C. Warrington
- *Electrical Power Systems* – C.L. Wadhwa (Protection Chapters)
- *Switchgear & Protection* – M.V. Deshpande

Online Platforms:

- NPTEL:
  1. *Power System Protection* by Prof. Bhavesh Bhalja
  2. *Switchgear and Protection* by Prof. S. A. Khaparde

PRACTICAL LIST:

- Study of Construction and Operation of HRC Fuse and Drop-out Fuse.
- Characteristics of IDMT Overcurrent Relay Using Relay Test Kit.
- Study of Buchholz Relay and Its Operation.
- Testing of Oil Circuit Breaker (OCB) and Vacuum Circuit Breaker (VCB).
- CT Polarity Test and Ratio Verification.
- Overcurrent Relay Coordination Using Time-Current Curves (TCC).
- Study of Percentage Differential Relay for Transformer Protection.
- Simulation of Overcurrent Protection Using MATLAB/Simulink.
- Study of SF_6 Circuit Breaker Model/Components.
- Calibration of Instantaneous Overcurrent Relay.
- Study of Motor Protection Circuit (MPC) and Its Setting.
- Demonstration of Distance Relay Operation (Using Simulator/Software).
- Mini-Project: Design of Protection Scheme for a 11kV Feeder.

COURSE CODE: DEE602

COURSE NAME: INDUSTRIAL AUTOMATION

Course Objectives:

- To introduce the fundamental concepts, architecture, and benefits of industrial automation.
- To explain the working and programming of PLCs, SCADA, and HMIs.
- To analyze sensors, actuators, and control systems used in automated processes.
- To develop skills in designing, programming, and troubleshooting basic automation systems.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain the levels of automation, system architecture, and components of an automated system.
CO2	Program and troubleshoot PLCs for industrial applications using ladder logic.
C03	Interface sensors, actuators, and HMIs with PLC systems.
C04	Design basic automation systems for processes like conveyor control, batch processing, and motor sequencing.

Unit	Content	Credit	Weightage
I	**Fundamentals of Industrial Automation** • Introduction to automation: need, benefits, and types (fixed, programmable, flexible). • Architecture of industrial automation: field level, control level, supervision level, enterprise level. • Components: sensors, transducers, actuators, controllers. • Overview of automation tools: PLC, SCADA, DCS, HMI, robotics. • Process control basics: open-loop vs closed-loop control, ON/OFF control, PID introduction. • Safety in automation: emergency stop, safety relays, interlocks.	1	25%

II	**Programmable Logic Controllers (PLCs)** • PLC architecture: CPU, memory, I/O modules, power supply. • PLC programming languages: ladder diagram (LD), function block diagram (FBD), structured text (ST) overview. • Ladder logic programming: relays, timers (TON, TOF, TP), counters (CTU, CTD, CTUD). • Data handling: data registers, move operations, arithmetic and comparison instructions. • PLC selection criteria: I/O count, memory, scan time, communication ports. • Introduction to IEC 61131-3 standard.	1	25%
III	**Sensors, Actuators & Drives in Automation** • **Sensors:** proximity (inductive, capacitive), photoelectric, temperature (RTD, thermocouple), pressure, level, flow sensors. • **Actuators:** solenoids, relays, contactors, pneumatic and hydraulic actuators. • **Drives:** variable frequency drives (VFD) for motor speed control. • Analog I/O interfacing with PLC. • Signal conditioning: isolation, amplification, filtering. • Motor control circuits: DOL, star-delta, reverse-forward with PLC.	1	25%
IV	**SCADA, HMI & Industrial Communication** • **SCADA:** architecture, functions, benefits, typical applications. • **HMI:** types, design principles, alarm management, trending. • **Industrial communication networks:** RS-232, RS-485, Ethernet, Profibus, Modbus (RTU, TCP/IP). • Introduction to DCS and its differences from PLC-SCADA. • Case studies: water treatment plant, conveyor system, packaging machine. • Industry 4.0 and IIoT (Industrial Internet of Things) overview.	1	25%

Textbooks:

- *Programmable Logic Controllers* – Frank D. Petruzella
- *Industrial Automation and Process Control* – Jon Stenerson
- *A Guide to the Automation Body of Knowledge* – Vernon L. Trevathan (Editor)

Reference books:

- *Automation, Production Systems, and Computer-Integrated Manufacturing* – Mikell P. Groover
- *PLC Programming Using RSLogix 5000* – Nathan Clark
- *SCADA: Supervisory Control and Data Acquisition* – Stuart A. Boyer

Online Platforms:

- NPTEL:
  1. *Industrial Automation and Control* by Prof. S. Mukhopadhyay
  2. *Programmable Logic Controllers* by Prof. S. Majhi

PRACTICAL LIST:

- Study of Different Types of Sensors (Proximity, Photoelectric, Temperature) and Their Characteristics.
- Interfacing of Sensors and Actuators with a PLC Trainer Kit.
- PLC Programming for Basic Logic Gates (AND, OR, NOT) Using Ladder Logic.
- Programming Timers and Counters for an Industrial Application (e.g., Conveyor Delay, Bottle Counting).
- PLC Program for Motor Control: Start/Stop, Forward/Reverse, and Star-Delta Starting.
- Design of a Traffic Light Control System Using PLC.
- Programming a Batch Mixing Process Using PLC (with Level Sensors).
- Interfacing Analog Sensor (e.g., Temperature) with PLC and Scaling the Input.
- Creating an HMI Screen for Motor Control with Start/Stop, Speed Indication, and Alarms.
- Study of SCADA System: Creating a Simple Project for Tank Level Monitoring.
- Communication Between PLC and PC/VFD Using Modbus Protocol.
- Troubleshooting a Faulty Ladder Logic Program.
- Mini-Project: Automated Car Parking System or Elevator Control Using PLC.

COURSE CODE: DEE603

COURSE NAME: ENERGY MANAGEMENT AND AUDIT

Course Objectives:

- To introduce the concepts, scope, and importance of energy management and conservation.
- To explain the methodology of conducting energy audits in industrial and commercial facilities.
- To analyze energy performance of electrical systems and identify conservation opportunities.
- To develop skills in measuring energy parameters, calculating savings, and preparing audit reports.

Course Outcomes: At the end of the course students shall be able to

CO1	Explain energy management principles, energy policies, and legal frameworks.
CO2	Conduct walk-through and detailed energy audits using appropriate instruments.
C03	Analyze energy consumption patterns and identify savings in motors, lighting, HVAC, and utilities.
C04	Prepare energy audit reports with techno-economic analysis of conservation measures.

Unit	Content	Credit	Weightage
I	**Fundamentals of Energy Management** • Energy scenario: global and national, primary and secondary energy sources. • Concept of energy management: need, objectives, and benefits.	1	25%

	• Energy management framework: organizational structure, energy manager roles. • Energy policies and acts: Energy Conservation Act 2001, BEE (Bureau of Energy Efficiency), PAT scheme. • Basic energy concepts: units, calorific value, energy and power, load factor, diversity factor. • Energy pricing: tariff structures, time-of-day pricing.		
II	**Energy Audit Methodology** • Definition and types of energy audit: preliminary, detailed, investment-grade. • Energy audit process: pre-audit, audit, post-audit phases. • Data collection: utility bills, layout drawings, equipment inventory, operational data. • Energy audit instruments: lux meter, power analyzer, thermometer, anemometer, infrared thermometer, flow meter. • Energy performance indicators (EnPI): specific energy consumption (SEC). • Cost-benefit analysis: payback period, NPV, IRR (simple calculations).	1	25%
III	**Energy Efficiency in Electrical Systems** • **Electric motors:** efficiency classes (IE1, IE2, IE3), loading assessment, rewinding issues, variable speed drives. • **Lighting systems:** efficacy of lamps (LED, CFL, tubular), lighting control, daylight harvesting. • **HVAC systems:** coefficient of performance (COP), EE measures, building envelope. • **Compressed air systems:** leakage detection, efficient operation. • **Power factor improvement:** capacitor sizing, location, benefits. • **Transformer losses** and selection for optimal loading.	1	25%
IV	**Energy Conservation & Reporting** • **Renewable energy integration:** rooftop solar, solar water heating. • **Waste heat recovery** opportunities. • **Building Energy Management Systems (BEMS).** • **Energy conservation case studies:** industry-specific (textile, cement, chemical). • **Energy audit report preparation:** structure, recommendations, implementation plan. • **Financing options:** ESCO model, government subsidies.	1	25%

Textbooks:

- *Handbook of Energy Audit* – Sonal Desai
- *Energy Management and Conservation* – K.V. Sharma & P. Venkataseshaiah
- *Energy Management* – Paul W. O'Callaghan

Reference books:

- *Energy Efficiency in Electrical Systems* – K.C. Mohanty
- *Guide to Energy Management* – Barney L. Capehart, Wayne C. Turner, William J. Kennedy
- *Energy Management Handbook* – Wayne C. Turner

Online Platforms:

- NPTEL:
  1. *Energy Management* by Prof. S. Banerjee
  2. *Energy Conservation in Electrical Systems* by Prof. C. S. Solanki

PRACTICAL LIST:

- Study of Energy Bills (Electricity, Fuel) and Calculation of Monthly Energy Cost.
- Measurement of Illumination Levels in Different Areas Using Lux Meter.
- Load Survey and Load Curve Plotting for a Small Facility/Workshop.
- Power Quality Analysis Using Power Analyzer: Measurement of PF, THD, Load Current.
- Motor Loading Assessment Using Clamp-on Power Meter and Calculation of Efficiency.
- Identification of Compressed Air Leakages Using Ultrasonic Leak Detector (Demo).
- Thermal Imaging for Identifying Heat Losses (Demo with IR Camera).
- Calculation of Capacitor Bank Rating for Power Factor Improvement.
- Comparative Study of Different Lamps (Incandescent, CFL, LED) for Efficacy and Cost.
- Walk-Through Energy Audit of Institute Building/Workshop and Preparation of Checklist.
- Calculation of Simple Payback Period for an Energy Conservation Measure (e.g., LED Replacement).
- Case Study Analysis: Energy Savings in an Industry from BEE Website.
  Mini-Project: Detailed Energy Audit Report for a Small Commercial Facility.