# Detailed Curriculum for Undergraduate Degree
# B.Tech in Electrical Engineering
# (w.e.f. AY: 2025-26)

## Part VI: Detailed Curriculum of 3rd semester

| **Course Name**: | **Engineering Mechanics** | | |
|---|---|---|---|
| **Course Code**: | ES-ME301 | **Category:** | Engineering Sciences Courses |
| **Semester**: | Third | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Physics (BS-PH-201), Mathematics (BS-M101, BS-M20) |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | Introduce essential mathematical tools required for the analysis of physical and mechanical systems. |
| 2 | Develop the ability to apply appropriate mathematical techniques for modeling and analyzing physical bodies. |
| 3 | Provide fundamental methods for the analysis of rigid body behavior. |
| 4 | To solve problem of general motion. |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Fundamental Principles of Forces, Vectors, and Moments** Basic concepts: Definitions, Basic assumptions, Scalar & Vector quantities, Free, Forced and fixed vectors. Force System: Force, Classification & Representation, Force as a Vector, Composition of forces, Parallelogram Law, Resolution, Principle of Transmissibility of forces, Moment of a force, Vector representation, Moment for coplanar force system, Varignon's theorem. | **4L** |
| 2 | **Analysis of Force Systems, Couples, and Equilibrium in Statics** Resolution of a force into a force and a couple. Force Systems: Coplanar | **3L** |

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| | Concurrent Force system and Coplanar Non-Concurrent force systems, Resultant of coplanar force system. Equilibrium of coplanar force system, Couple, Vector representation, Free body diagrams. | |
| 3 | **Kinematics of Rigid Body**<br>Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two- and three-dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula. | **6L** |
| 4 | **Kinetics of Rigid Bodies**<br>Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moments and axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion. | **5L** |
| 5 | **General Motion of Rigid Bodies and Gyroscopic Phenomena**<br>Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin. | **9L** |
| 6 | **Shear Force and Bending Moment Analysis of Beams**<br>Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between loading, shear force and bending moment, shear force and bending moment diagrams. | **5L** |
| 7 | **Torsional Motion**<br>Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts. | **2L** |
| 8 | **Friction**<br>Concept of Friction, Laws of Coulomb friction, Angle of Repose and Coefficient of friction. | **3L** |
| 9 | **Vibrations**<br>Free and forced vibration of undamped and damped single DOF systems, Effect of damping, Vibration Isolation, Critical Speed of Shafts. | **3L** |
| **Total** | | **40L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand coordinate systems, three-dimensional rotation, and the basic kinematics and kinetics of rigid bodies. |
| 2 | Explain the principles of general motion, bending moment, torsional motion, and |

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| | friction. |
| 3 | Construct free body diagrams for different mechanical systems and loading conditions. |
| 4 | Apply the laws of motion and friction to solve engineering problems involving rigid bodies. |
| 5 | Analyse bending moments and torsional behaviour in mechanical components. |

| **Learning Resources:** | |
|---|---|
| 1 | M. F. Beatty, "Principles of Engineering Mechanics", Springer Science & Business Media, 1986. |
| 2 | J. L. Meriam and L. G. Kraige, "Engineering Mechanics: Dynamics", Wiley, 2011. |
| 3 | Manoj K. Harbola, "Engineering Mechanics", Cengage Learning India Pvt. Ltd, 2018. |
| 4 | R.S. Khurmi, "Engineering Mechanics", S.Chand Publications. |
| 5 | R.K. Bansal, "Engineering Mechanics", Laxmi Publications. |

| **Corresponding NPTEL/SWAYAM Courses:** | | | |
|---|---|---|---|
| **Sl. No.** | **Course Name** | **Instructor Name** | **Host Institute** |
| 1 | Engineering Mechanics | By Prof. K. Ramesh | IIT Madras |
| | **Course Link: https://onlinecourses.nptel.ac.in/noc21_me70/preview** | | |
| 2 | Engineering Mechanics - Statics and Dynamics | By Prof. Anubhab Roy | IIT Madras |
| | **Course Link: https://onlinecourses.nptel.ac.in/noc25_me20/preview** | | |

| **Course Name**: | **Electrical Engineering Materials** | | |
|---|---|---|---|
| **Course Code**: | ES-EE301 | **Category:** | Engineering Science Courses |
| **Semester**: | Third | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To introduce the fundamental concepts of atomic structure and bonding in solids relevant to electrical engineering materials. |

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| 2 | To understand dielectric properties of materials under static and alternating electric fields. |
| 3 | To explain electrical conduction mechanisms in metals and semiconductors. |
| 4 | To analyze the characteristics and applications of magnetic and insulating materials used in electrical engineering systems. |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Atomic Structure and Bonding in Solids:** Fundamentals of electrical engineering materials & its classification, Atomic structure and hydrogen atom model, quantum mechanical interpretation, electronic configuration of atoms, types of chemical bonds (ionic, covalent, metallic), classification of solids, crystal structure and atomic arrangements in solids. | **6L** |
| 2 | **Electrical Conduction in Metals:**<br>Ohm's law and relaxation time of electrons, Relaxation time, collision time and mean free path, Electron scattering and the resistivity of metals, Heat developed in a current carrying conductor, Thermal conductivity of metals, Emission of electrons from metals, Effect of temperature on electrical conductivity of metals, High conductivity materials, Superconductors and hyper-conductors, Superconductors and hyper-conductors, Electrical conducting materials, Thermal properties, Specific heat of metals, Contributions of electrons to the heat capacity of metals.<br>Conduction in Carbon, Tungsten, high resistive materials etc., | **6L** |
| 3 | **Dielectric and Insulating Materials:**<br>Introduction to dielectric materials, dielectric constant, polarization mechanisms, atomic interpretation of dielectric constant, dielectric behavior of monoatomic and polyatomic molecules, internal electric fields in solids and liquids, dielectric constant of solids, properties of ferroelectric materials, polarization, Piezoelectricity.<br>Classification of dielectric materials, Gaseous dielectrics, petroleum oil, Synthetic liquid dielectrics, organic polymer, resins, vegetable oil, bitumen, waxy dielectrics, electrical varnishes and compounds, flexible materials, plastics, elastomers, glasses, ceramic dielectric materials, mica and mica materials, asbestos and asbestos materials, inorganic dielectric films. | **12L** |
| 4 | **Electrical Conduction in liquids:** | **5L** |

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| | Electrolytic conduction, Electrons in electrolysis different, Experimental evidence for dissociation, Equivalent conductivity, Ionic velocities, Chemical cells and concentration cells, Irreversible and reversible cells, Practical cells, Electrolytic deposition, Uses of electrolytic depositions. | |
| 5 | **Magnetic Materials:**<br>Classification of magnetic materials (diamagnetic, paramagnetic, ferromagnetic), magnetic dipole and dipole moment, Lenz's law, Diamagnetism, Paramagnetism and paramagnetic spin systems, Spontaneous magnetization and the Curie-Weiss law, magnetization curve, hysteresis loops, hysteresis and magnetic losses, Common magnetic materials, Anti-ferromagnetism, Ferrimagnetism, Magnetic resonance. | **6L** |
| **Total** | | **35L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Explain atomic structure, bonding, and crystal arrangements in electrical engineering materials. |
| 2 | Analyze dielectric behavior of materials under static and alternating electric fields. |
| 3 | Evaluate electrical conduction mechanisms in metallic materials. |
| 4 | Understand semiconductor properties and their importance in electronic devices. |
| 5 | Classify magnetic and insulating materials and relate their properties to engineering applications. |

| **Learning Resources:** | |
|---|---|
| **Text book** | |
| 1 | **An Introduction to Electrical Engineering Materials** by C.S Indulkar and S. Thiruvengadam. |
| 2 | **Electrical Engineering Materials** by A.J. Dekker |
| **Reference Book** | |
| 3 | **Electrical Engineering Materials by** N. P. Bogoroditsky, V.V. Pasynkov and B. M. Tareev. |
| 4 | **Electrical and Radio Engineering Materials** by B. M. Tareev. |
| 5 | **Electrical and Electronics Materials** by D. P. Kothari, Mahima Join and Sheefali Jagwani. |

| **Course Name**: | **Network Analysis** | | |
|---|---|---|---|
| **Course Code**: | PC-EE301 | **Category:** | Professional |

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| | | | Core Courses |
| **Semester**: | Third | **Credit:** | 4 |
| **L-T-P**: | 3-1-0 | **Pre-Requisites:** | Basic Electrical and Electronics Engineering (ES-EE 201) and Mathematics (BS-M101, BS-M201) |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To understand the structure and properties of different type of electrical circuits, networks and sources. |
| 2 | To apply different mathematical tools and techniques for analyzing electrical networks. |
| 3 | To apply circuit analysis techniques to simplify electrical networks. |
| 4 | To solve problems of electrical circuits. |

| **Course Contents:** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |
| 1 | **Introduction**: Continuous and Discrete, Fixed and Time varying, Linear and Nonlinear, Lumped and Distributed, Passive and Active networks and systems. Independent and Dependent sources, Step, Ramp, Impulse, Sinusoidal, Square, Saw tooth signals. | **4L** |
| 2 | **Graph theory and Networks equations:** Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials, Duality, Related Problems. | **4L** |
| 3 | **Coupled circuits:** Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, Related Problems. | **3L** |
| 4 | **Laplace transforms:** Impulse, Step and Sinusoidal response of RL, RC, and RLC circuits, Transient analysis of different electrical circuits with and without initial conditions, Concept of Convolution theorem and its application, Related Problems with DC and AC sources. | **8L** |
| 5 | **Fourier method of waveform analysis:** Application of Fourier series and Fourier Transform (in continuous domain only) in circuit | **5L** |

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| | analysis, related problems. | |
| 6 | **Network Theorems:** Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis, Network theorem: Superposition, Thevenin‟s, Norton‟s and Maximum power transfer theorem, Millman‟s theorem and its application in three phase unbalanced circuit analysis, Related Problems with DC and AC sources, Dependent and independent voltage and current source and numerical problems. | **8L** |
| 7 | **Two port networks analysis:** Open circuit Impedance and Short circuit Admittance parameter, Transmission parameters, Hybrid parameters and their inter relations, Related Problems. | **6L** |
| 8 | **Filter Circuits:** Analysis and synthesis of Low pass, High pass, Band pass, Band reject (first order only) filter, Related Problems. | **2L** |
| **Total** | | **40L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Explain the behavior of different signals and systems. |
| 2 | Apply Laplace and Fourier transforms for solving different electrical problems. |
| 3 | Analyze complicated Electrical network with the help of different network theorems |
| 4 | Solve different electrical problem in a simplified way by graph theory. |
| 5 | Determine different parameters from a given two port electrical network. |
| 6 | Understand the application of active filters for different electric circuit. |

| **Learning Resources:** | |
|---|---|
| **Recommended Text books:** | |
| 1. | Network Analysis, M.E. Valkenburg, Pearson Education |
| 2. | Circuit theory, Dr. Abhijit Chakrabarty, Dhanpat Rai and Co Pvt. Ltd |
| 3. | Networks and Systems, D. Roy Chowdhury, New Age International Publishers |
| **Alternative Text Books:** | |
| 4. | Circuit and Networks: Analysis and synthesis, A. Sudhakar and S.S. Palli4th edition. Tata Mc Graw Hill Education Pvt. Ltd. |
| 5. | Networks and Systems, Ashfaq Husain, Khanna Book Publishing, New Delhi |
| 6. | Problems and Solutions of Electric Circuit Analysis, R.K. Mehta and A.K. Mal, CBS, New Delhi |

| Reference Books: | |
|---|---|
| 7. | Fundamental of Electric circuit theory, D. Chattopadhay and P.C. Rakshit, S. Chand |
| 8. | Engineering Circuit Analysis, W.H. Hyat, J.E. Kemmerly and S.M. Durbin, The Mc Graw Hill Company |
| 9. | Network Analysis and Synthesis, C.L. Wadhwa, New Age International Publishers |

| Corresponding NPTEL/SWAYAM Courses: | | | |
|---|---|---|---|
| **Sl. No.** | **Course Name** | **Instructor Name** | **Host Institute** |
| 1 | Network Analysis | Prof. Tapas Kumar Bhattacharya | IIT Kharagpur |
| | **Course Link:** http://digimat.in/nptel/courses/video/108105159/L01.html | | |

| **Course Name**: | **Electromagnetic Fields Theory** | | |
|---|---|---|---|
| **Course Code**: | PC-EE302 | **Category:** | Professional Core Courses |
| **Semester**: | Third | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Basic Electrical & Electronics Engineering (ES-EE 201), Mathematics (BS-M101, BS-M201) and Physics (BS-PH201) |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| Course Objectives: | |
|---|---|
| 1 | To understand the basic mathematical tools to deal with electromagnetic field problem. |
| 2 | To understand properties and application of electric and magnetic field. |
| 3 | To analyze electromagnetic wave propagation. |
| 4 | To solve problem related to electromagnetic field. |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Introduction to Coordinate System:** Co-ordinate systems and transformation, Cartesian coordinates, circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different coordinate systems. Solution of problems. | **4L** |
| 2 | **Introduction to Vector calculus:** DEL operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Strokes theorem, Laplacian of a scalar, Classification of vector fields, Helmholtz's theorem, Solution of problems. | **4L** |
| 3 | **Electrostatic field:** Coulomb's law, Field intensity, Gauss's law, Electric Potential and Potential gradient, Relation between E and V, an Electric dipole and flux lines. Energy density in electrostatic field. Boundary conditions: Dielectric-dielectric, Conductor-dielectric, Conductor –free space. Poisson's and Laplace's equation, general procedure for solving Poisson's and Laplace's equation. Solution of problems. | **8L** |
| 4 | **Magneto static fields:** Biot-Savart law, Ampere's circuital Law, Magnetic flux density, Magnetic static and Vector potential, Forces due to magnetic field, Magnetic torque and moments, Magnetization in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy, Force on magnetic material. Solution of problems. | **8L** |
| 5 | **Electromagnetic fields:** Faraday's law, transformer and motional emf, Displacement current, Maxwell's equation, Time varying Potential, Time harmonic fields. Solution of problems. | **6L** |
| 6 | **Electromagnetic wave propagation:** Wave equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good conductor, Skin effect, Skin depth, Power & Poynting vector, Reflection of a plane wave at normal incidence, Reflection of a plane wave at oblique incidence, Polarization. Solution of problems. | **6L** |
| **Total** | | **36L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand concept of coordinate transformation with the knowledge of vector |

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| | calculus and several theorems (Divergence theorem, Strokes theorem and Helmholtz's theorem) |
| 2 | Apply the knowledge of Biot-Savart's Law & Gauss's Law to solve boundary condition problems with the concept of Poisson's and Laplace's equation. |
| 3 | Apply the knowledge of Biot-Savart's Law and Ampere's circuital Law to solve problems related to magnetic circuits. |
| 4 | Determine the effects of Transformer EMF and Motional EMF, wave equation, skin effect, skin depth having the concept of Maxwell's equation and Pointing Theorem. |

| **Learning Resources:** | |
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| **Recommended Text Books:** | |
| 1 | Engineering Electromagnetic, W.H. Hyat & J.A. Buck, 7th Edition, TMH |
| 2 | Elements of Electromagnetic, Mathew N.O. Sadiku, 4th edition, Oxford university press |
| **Alternative Text Books:** | |
| 3 | Electromagnetic Field Theory, S. P. Ghosh, Tata Mc Graw-Hill |
| **Reference Books:** | |
| 4 | Vector Analysis, Schaum Series, Murray R. Spiegel, McGraw-Hill |
| 5 | Theory and problems of Electromagnetic, Edminister, 2nd Edition, TMH |
| 6 | Electromagnetic field theory fundamentals, Guru & Hizroglu, 2nd edition, Cambridge University |

| **Corresponding NPTEL/SWAYAM Courses:** | | | |
|---|---|---|---|
| **Sl. No.** | **Course Name** | **Instructor Name** | **Host Institute** |
| 1 | Electromagnetic Waves in Guided and Wireless Media | Prof. Pradeep Kumar K | IIT Kanpur |
| | **Course Link:** https://onlinecourses.nptel.ac.in/noc26_ee40/preview | | |

| **Course Name**: | **Analog Electronics** | | |
|---|---|---|---|
| **Course Code**: | PC-EE303 | **Category:** | Professional Core Courses |
| **Semester**: | Third | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Basic Electrical and Electronics |

| | | | |
|---|---|---|---|
| | | | Engineering (ES-EE 201) and Mathematics (BS-M101, BS-M201) |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To understand the structure and properties of different components of analog electronics. |
| 2 | To explain principle of operation of analog electronics components and circuits. |
| 3 | To understand the application of operational amplifier |
| 4 | To solve problems of analog electronic components and circuits |
| 5 | To analyze amplifiers, oscillators and other analog electronic circuits. |

| **Course Contents:** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |
| 1 | **Filters and Regulators:** Half wave and full wave rectifier with Capacitor filters, □-section filter, T-section filter, ripple factor, regulated power supply. | **3L** |
| 2 | **BJT circuits:** BJT as a switch. biasing circuits, BJT as an amplifier: small-signal model, biasing circuits, common-emitter, common-base and common-collector amplifiers; Multistage amplifier, Small signal equivalent circuits. | **8L** |
| 3 | **MOSFET circuits:** MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common- source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans- conductance. | **8L** |
| 4 | **Power amplifier:** Power Amplifier: Introduction to the Power Amplifiers, Classification of Power Amplifiers, Class A, Class B (Push-Pull), Class AB and Class C Power Amplifier. Applications | **2L** |
| 5 | **Feedback amplifier and Oscillators:** Concept of Feedback, Negative and Positive feedback, Voltage/Current, Series/Shunt feedback, Colpit, Hartley's, Phase shift, Wien bridge oscillators. | **4L** |
| 6 | **Review and Application of Operational Amplifiers:** Constant current source (Current mirror etc.), CMRR, Open and closed loop | |

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| | circuits, Voltage follower/Buffer circuits, Level shifter, Voltage to current and Current to Voltage converter, Adder, Differential amplifier, Integrator and Differentiator, Comparator, Log and Antilog amplifier, Schmitt Trigger, Transconductance amplifier, Multiplier/Divisor using OPAMP. | **9L** |
| 7 | **Multivibrator:** Monostable, Bistable multivibrator, Monostable and Astable operation using 555 timer, Introduction to VCO and PLL. | **2L** |
| **Total** | | **36L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand the operation of rectifier, filter and voltage regulator. |
| 2 | Analyze the operation of transistor circuits as analog building block. |
| 3 | Understand the operation of OPAMPs as different active linear circuits. |
| 4 | Interpret the operation of feedback in amplifiers and oscillators. |
| 5 | Understand amplifier-based circuits for different applications. |

| **Learning Resources:** | |
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| **Recommended Text Books:** | |
| 1 | Malvino and Bates, Electronic Principles, McGraw-Hill Education |
| 2 | D Chattopadhyay, P C Rakshit, Electronics Fundamentals and Applications, New Age International Publisher |
| 3 | Ramakant A. Gayakwad -- Op-Amps and Linear Integrated Circuits, 4/e, Pearson-PHI |
| 4 | Microelectronic Circuits by SEDRA and SMITH, Oxford |
| 5 | A.K. Maini, Analog Electronics, Khanna Publishing House 2019 |
| **Alternative Text Books:** | |
| 5 | Floyd, Electronic Devices, Pearson |
| 6 | David A. Bell, Electronic Devices and Circuits, Oxford |
| 7 | I.J. Nagrath, Electronics: Analog and Digital, PHI |
| 8 | Millman & Halkias – Integrated Electronics, Tata McGraw Hill |
| 9 | Boylestead, Nashelsky: & Kishore, Electronic Devices & Circuit theory, 1/e, PHI/Pearson |
| 10 | D. Roy Choudhury, Linear Integrated Circuits, New Age International Publisher |
| **Reference Books:** | |
| 11 | Maheshwari and Anand, Analog Electronics, PHI |
| 12 | Sundaram Natarajan, Microelectronics: Analysis & Design, 1/e 2005, TMH |
| 13 | Dipankar Nagchoudhuri, Microelectronic Devices, 1/e, Pearson Education, 2001 |

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| 14 | Mottershed, Electronics Devices & Circuits, Wiley Eastern |

| **Corresponding NPTEL/SWAYAM Courses:** | | | |
|---|---|---|---|
| **Sl. No.** | **Course Name** | **Instructor Name** | **Host Institute** |
| 1 | Analog Electronic Circuit | Prof. Shouribrata chatterjee | IIT Delhi |
| | **Course Link:** https://nptel.ac.in/courses/108102112 | | |
| 2 | Analog Electronic Circuits - IITM | Prof. Shanthi Pavan | IIT Madras |
| | **Course Link:** https://nptel.ac.in/courses/108106188 | | |

| **Course Name**: | **Digital Electronics** | | |
|---|---|---|---|
| **Course Code**: | PC-EE304 | **Category:** | Professional Core Courses |
| **Semester**: | Third | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Basic Electronics ES-EE101 |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | Understand number systems, binary arithmetic, Boolean algebra, and logic gate fundamentals for digital system analysis. |
| 2 | Develop the ability to design and minimize combinational logic circuits using K-map and Quine–McCluskey methods. |
| 3 | Analyze and design sequential circuits using flip-flops, registers, and counters for practical digital applications. |
| 4 | Explain the operation and performance characteristics of A/D and D/A converters used in digital systems. |
| 5 | Understand memory organization and programmable logic devices such as ROM, RAM, PLA and PAL. |

| **Course Contents:** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |

| | | |
|---|---|---|
| 1 | **Digital Systems and Binary numbers:** Binary, decimal, octal, hexadecimal number systems, number base conversions, complements, signed binary numbers, binary logic, binary arithmetic. **Boolean Algebra and Logic Gates:** Basic theorems and properties of Boolean algebra, Boolean functions, canonical and standard forms, digital logic gates, digital logic families and integrated circuits**.** Standard representation for logic functions, K-map representation, simplification of Logic functions using K-map, minimization of logical functions. Don't care conditions. Q-M method of function realization. | **10L** |
| 2 | **Combinational Digital Circuits:** Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, digital comparator, parity checker/generator, codes and code converters, priority encoders, decoders/drivers for display devices. | **5L** |
| 3 | **Sequential circuit and systems:** **Flip-Flops:** A 1-bit memory, the circuit properties of Bistable latch, RS Flip flop, Clocked RS flip-flop, JK flip-flop, D and T-flip-flop, Conversion of flip-flops, applications of flip-flops. **Registers:** Shift Registers (Left shift and Right shift register), Universal shift register: SISO, SIPO, PISO, PIPO **Counters:** Ring counter, ripple(Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters. **Comparators & Converters:** Basic comparator & its characteristics, Serial to parallel converter, parallel to serial converter. | **7L** |
| 4 | **A/D and D/A Converters:** **Digital to analog converters:** weighted resistor/ converter, R-2R Ladder, D/A converter, specifications for D/A converters, examples of D/A converter, ICs. **Analog to digital converters:** quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs. | **7L** |
| 5 | **Semiconductor memories and Programmable logic devices:** Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read | **6L** |

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| | only memory (ROM), read and write memory (RAM), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic. | |
| **Total** | | **35L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand number system conversions and Boolean algebra principles to simplify and analyze digital logic circuits. |
| 2 | Design and implement combinational circuits such as adders, subtractors, multiplexers, decoders, comparators, and ALU. |
| 3 | Design and analyze sequential circuits using flip-flops, registers, and counters for specified applications. |
| 4 | Evaluate and compare different A/D and D/A conversion techniques based on their specifications and performance. |
| 5 | Explain the organization and working of semiconductor memories and programmable logic devices and apply them in basic digital system design. |

| **Learning Resources:** | |
|---|---|
| **Recommended Text Books** | |
| 1 | Modern Digital Electronics, 4th Edition, R.P. Jain. Tata Mc Graw Hill Company Limited |
| 2 | Digital Logic Design, M. Morries Mano, Pearson Education, 2002. |
| **Alternative Text Books** | |
| 3 | Digital Electronics, R. Anand, Khanna Publishing House (2018). |
| 4 | Digital Integrated Electronics, H. Taub & D. Shilling, Mc Graw Hill Company. |
| 5 | Digital Electronics, Principles, Devices and Applications, Anil K. Maini,Jhon Wiley & Sons, Ltd, 2007. |
| **Reference Books** | |
| 6 | Digital fundamentals, Floyd, Thomas L, 10/e. Pearson Education India, 2011. |
| 7 | Digital Electronics, Gothmann, William H. PHI, New Delhi, Second Edition 2000. |

**Corresponding NPTEL/SWAYAM Courses:**

| Sl. No. | Course Name | Instructor Name | Host Institute |
|---|---|---|---|
| 1 | Digital Electronic Circuits | Prof. Goutam Saha | Indian Institute of Technology Kharagpur |
| | **Course Link:** https://onlinecourses.nptel.ac.in/noc22_ee55/preview | | |

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|---|---|---|---|
| 2 | Digital Circuits | Prof. Santanu Chattopadhyay | Indian Institute of Technology Kharagpur |
| | **Course Link:** https://www.youtube.com/watch?v=X7M3rUxUpOc&list=PLbRMhDVUMngePP5JcezxImF-FzOC9wstz | | |

| | | | |
|---|---|---|---|
| **Course Name:** | **Network Analysis Laboratory** | | |
| **Course Code:** | PC-EE391 | **Category:** | Professional Core Courses |
| **Semester:** | Third | **Credit:** | 1 |
| **L-T-P:** | 0-0-2 | **Pre-Requisites:** | Nil |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 60 | Continuous Assessment: 35 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To simulate electrical circuit experiments using suitable software. |
| 2 | To determine different electrical circuit parameters using hardware. |
| 3 | To get frequency response of different filters using simulation and hardware technique. |
| 4 | To verify different network theorems. |

| **Course Contents: (Choose 8 experiments from the following)** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |
| 1 | Transient response of R-L and R-C network: simulation with software and hardware | **3P** |
| 2 | Transient response of R-L-C series and parallel circuit: simulation with software and hardware | **3P** |
| 3 | Determination of Impedance (Z) and Admittance (Y) parameter of two port network: simulation and hardware. | **3P** |
| 4 | Frequency response of LP and HP filters: simulation and hardware | **3P** |
| 5 | Generation of Periodic, Exponential, Sinusoidal, Damped Sinusoidal, Step, Impulse, Ramp signal using simulation software in both discrete and analog form. | **3P** |
| 6 | Determination of Laplace transform and Inverse Laplace transform using simulation software | **3P** |

| | | |
|---|---|---|
| 7 | Fourier series analysis of different waveforms. | **3P** |
| 8 | Amplitude and Phase spectrum analysis of different signals using simulation software. | **3P** |
| 9 | Verification of network theorems using software and hardware. | **3P** |
| **Total** | | **24P** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Demonstrate transient response of different electrical circuit. |
| 2 | Calculate different parameters from a two port network. |
| 3 | Demonstrate frequency response of different active filter circuit. |
| 4 | Simulate different operation of signals for output waveform using MATLAB |
| 5 | Calculate Laplace and inverse Laplace transform of different functions using MATLAB |
| 6 | Analyze different network theorems. |

| **Course Name**: | **Analog and Digital Electronics Laboratory** | | |
|---|---|---|---|
| **Course Code**: | PC-EE393 | **Category:** | Professional Core Courses |
| **Semester**: | Third | **Credit:** | 1 |
| **L-T-P**: | 0-0-2 | **Pre-Requisites:** | Nil |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 60 | Continuous Assessment: 35 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To make the students concept about to design, experiment, analyze, interpret in the core field. |
| 2 | To provide knowledge based on the needs of society and industry by providing hands on experience. |
| 3 | To provide the clear concept of theoretical knowledge's by providing practical experiments. |

| **Course Contents: (Choose 10 experiments from the following)** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |
| 1 | Study of ripple and regulation characteristics of full wave rectifier with and without capacitor filter. | **2P** |

| | | |
|---|---|---|
| 2 | Study of Zener diode as voltage regulator. | **2P** |
| 3 | Study of timer circuit using NE555 and configuration for Monostable and Astable Multivibrator | **2P** |
| 4 | Construction of a simple function generator using IC. | **2P** |
| 5 | Realization of a V-to-I and I-to-V converter using Op-Amps. | **2P** |
| 6 | Realization of basic gates using Universal logic gates. | **2P** |
| 7 | Construction of simple Decoder & Multiplexer circuits using logic gates. | **2P** |
| 8 | Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexer | **2P** |
| 9 | Realization of RS-JK & D flip-flops using Universal logic gates. | **2P** |
| 10 | Realization of Synchronous Up/Down counter | **2P** |
| 11 | Study of A-D and D-A converter. | **2P** |
| **Total** | | **20P** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Construct a full wave rectifier circuit and voltage regulator using discrete components and study their performance. |
| 2 | Construct the different circuits using amplifier, waveform generator using 555 timer and study their performance. |
| 3 | Realize RS-JK and D flip flop, logic gates using universal gates and synchronous up/down counters. |
| 4 | Construct different combinational circuits using logic gates with appropriate instruments and precaution. |

# Detailed Curriculum for Minor Degree under Department of Electrical Engineering (w.e.f. AY: 2025-26)

## Part VII: Detailed Syllabus of 3rd semester for Minor Degree

### A. Minor Degree in Power Engineering

| | | | |
|---|---|---|---|
| **Course Name**: | **Thermal Power Generation** | | |
| **Course Code**: | MN-EE301A | **Category:** | Minor |
| **Semester**: | Third | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To develop an understanding of thermodynamic cycles used in thermal power plants, including Rankine, reheat, and regenerative cycles. |
| 2 | To provide detailed knowledge of steam generators, fuel-firing systems, boiler components, and emission control techniques. |
| 3 | Explain the working principles and performance characteristics of steam turbines and associated components. |
| 4 | To introduce students to overall thermal power plant layout, operation, efficiency improvement techniques, and environmental considerations. |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1. | Analysis of Steam cycle - Rankine cycle, mean temperature of heat addition, effects of variation of steam condition on thermal efficiency, Reheat cycle, Regenerative cycle, Optimum degree of reheat and regeneration, supercritical pressure cycle. | **5L** |
| 2. | **Steam Generator** -- Classification, Layout of power plant steam generators, Fuel firing methods, Pulverized coal firing system, Coal burners and their arrangements, Oil firing in coal-fired steam generators, oil guns, Boiler furnace, Boiler pressure parts: economiser, evaporator, superheaters, reheaters, steam drum and drum internals, circulation, | **10L** |

| | | |
|---|---|---|
| | introduction to supercritical steam generators, steam temperature control, air preheater, introduction to emission control technologies: NOx, SOx and particulate emission control, steam generator performance. | |
| 3. | **Steam turbine** - Ideal and Actual flow of compressible fluid through nozzle, critical pressure ratio, maximum rate of discharge, Nozzle efficiency & velocity coefficient of nozzles. Classification of steam turbine, Flow through simple impulse turbine blading, velocity diagram, blade efficiency, Gross stage efficiency, net stage efficiency, optimum velocity ratio. Degree of admission. Multistaging or compounding of impulse turbine, velocity compounding, pressure compounding, velocity and pressure compounding, Reheat factor, internal efficiency, state point locus etc. in relation to steam turbine. Flow through Reaction turbine, velocity diagram, Degree of reaction, blade height, stage efficiency, optimum velocity ratio, axial thrust in reaction turbine. Comparisons of impulse & reaction turbine, Losses in turbines, Principle of turbine governing.<br>Condensers - Requirement and Types of condenser, Surface condenser construction and functioning, air-cooled condenser. | **20L** |
| **Total** | | **35L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1. | Explain the thermodynamics cycles of the thermal power generation and their variations. |
| 2. | Classify steam generators and illustrate the different components in them |
| 3. | Classify steam turbines and analyze the flow and energy transfer in them |
| 4. | Classify power plant condensers and analyze their operation and performance |

| **Learning Resources:** | |
|---|---|
| **Recommended Text Books** | |
| 1. | Power Plant Engineering" by P.K. Nag, 3rd Edition, Tata McGraw Hill Publishing Company Limited, 2008. |
| 2. | A Textbook of Power Plant Engineering, by R.K. Rajput Laxmi Publications, 2016. |
| **Alternative Text Books** | |
| 3. | Power Plant Engineering" by Dr. P.C. Sharma, S.K. Kataria & Sons,2001 |
| **Reference Books** | |
| 4. | Power Plant Engineering, by Black & Veatch, Springer, 1996 |

**Corresponding NPTEL/SWAYAM Courses:**

| Sl. No. | Course Name | Instructor Name | Host Institute |
|---|---|---|---|
| 1 | Power Plant System Engineering | Prof. Niranjan Sahoo | IIT Guwahati |
| | **Course Link:** https://onlinecourses.nptel.ac.in/noc24_me57/preview | | |
| 2 | Power Plant System Engineering | Prof. Niranjan Sahoo | IIT Guwahati |
| | **Course Link:** https://onlinecourses.nptel.ac.in/noc24_me57/preview | | |

## B. Minor Degree in High Voltage Engineering

| **Course Name**: | **Fundamental of High Voltage Engineering** | | |
|---|---|---|---|
| **Course Code**: | MN-EE301B | **Category:** | Minor |
| **Semester**: | Third | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To introduce the fundamental concepts of high voltage generation techniques for AC, DC, impulse, and switching surges used in laboratory and power system applications. |
| 2 | To develop an understanding of various measurement and testing methods for high voltages and currents, including modern digital techniques. |
| 3 | To study the behavior of different insulating materials (solid, liquid, and gaseous) and analyze breakdown mechanisms under high electric stress. |
| 4 | To provide knowledge of high voltage cable construction, insulation requirements, fault analysis, and testing methods in power systems. |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1. | **Generation of High Voltages:** Requirements of HV generation in laboratory, Generation of High voltages, AC voltages: Testing transformers-Series resonance circuits; DC voltages: symmetric and asymmetric voltage doubler circuits-electrostatic machines. Generation of Impulse voltages and currents: single stage and multistage circuits-wave shaping- modelling of impulse generator circuit-triggering | **09L** |

| | | |
|---|---|---|
| | and control of impulse generators. Generation of switching surge voltage and currents. Simulation of AC, DC and Impulse Voltage/Current generation circuits. | |
| 2. | **Measurement and Testing:**<br>Measurement of high voltages: Sphere gaps, factors affecting sphere gap measurements, correction factors. Measurement of high AC voltage: Capacitance voltage dividers, Chubb-Fortescue method, CVT, electrostatic voltmeters. Measurement of high DC voltage: Resistive voltage dividers, Generating voltmeter. Measurement of impulse voltage: Capacitance divider, Impedance matching. Measurement of transient currents: Resistive shunt, Magnetic coupling, Hall Effect current transducers Integrating and differentiating type Rogowski coils. Digital techniques in HV measurements, DSO. | **10L** |
| 3. | **Insulation materials and Breakdown:**<br>Introduction to solid, liquid and gaseous insulators used in power equipment. Classifications of insulation based on temperature withstand limits, dielectric losses, ageing of insulation materials (paper–press board) and remaining life analysis. Applications of nanofilled materials for outdoor and indoor insulation. Introduction to solid, liquid and gaseous dielectrics. Breakdown in gas and gas mixtures-breakdown in uniform and non uniform fields- Paschen's law-Townsends criterion-streamer mechanism-corona discharge-breakdown in electro negative gases. Breakdown in liquid dielectrics-suspended particle mechanism. Breakdown in solid dielectrics - intrinsic, streamer and thermal breakdown. | **10L** |
| 4. | **High voltage cables**<br>Classification of High Voltage Underground cables, insulation materials for cables, general construction of a single core UG cable, 3 core,3 1/2 core and 4 core cables. Essential properties required for insulating material of Underground cables. Methods of laying Underground cables. Faults in Underground cable. Testing of cables. | **06L** |
| **Total** | | **35L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Describe and analyze various generation and measurement techniques for high Voltages and Currents. |
| 2 | Understand the breakdown phenomenon in different insulating mediums. |
| 3 | Identify the over voltages in power systems and outline the principles of insulation coordination for various parts of power system. |
| 4 | Understand the construction and applications of high voltage cables. |

**Learning Resources:**

| | |
|---|---|
| **Recommended Text Books** | |
| 1 | Kuffel and Zaengl , High Voltage Engineering Fundamentals, 2nd ed., Newness, 2002. |
| 2 | M. S. Naidu, V. Kamaraju, High Voltage Engineering, 3rd ed., McGraw-Hill,1995. |
| **Alternative Text Books** | |
| 3 | M. Khalifa, High Voltage Engineering: Theory and Practice, Dekker, 1990. |
| 4 | H. M. Ryan, High Voltage Engineering and Testing, IEE 2001. |
| 5 | Kuffel and Abdullah.M, High Voltage Engineering, Pergamon press,1978. |
| **Reference Books** | |
| 6 | Wadhwa C L, High Voltage Engineering, New Age International, New Delhi,1994 |
| 7 | Relevant IS standards and IEC standards. |

| **Corresponding NPTEL/SWAYAM Courses:** | | | |
|---|---|---|---|
| **Sl. No.** | **Course Name** | **Instructor Name** | **Host Institute** |
| 1 | High Voltage Engineering | Prof. Ravindra Arora | IIT Kanpur |
| | **Course Link:** https://nptel.ac.in/courses/108104048 | | |