

**Code: EI****Instrumentation Engineering****Engineering Mathematics**

**Linear Algebra:** Matrices and Determinants, Systems of Linear Equations, Eigen Values and Eigen Vectors.

**Calculus:** Mean Value Theorems, Theorems of Integral Calculus, Evaluation of Definite and Improper Integrals, Partial Derivatives, Maxima and Minima, Multiple Integrals, Fourier Series. Vector Identities, Directional Derivatives, Line, Surface and Volume Integrals, Stokes, Gauss and Green's Theorems.

**Differential Equations:** First Order Equation (Linear and Nonlinear), Higher Order Linear Differential Equations with Constant Coefficients, Method of Variation of Parameters, Cauchy's and Euler's Equations, Initial and Boundary Value Problems, Partial Differential Equations and Variable Separable Method.

**Complex Variables:** Analytic Functions, Cauchy's Integral Theorem and Integral Formula, Taylor's and Laurent's Series, Residue Theorem, Solution Integrals.

**Probability and Statistics:** Probability, Sampling Theorems, Conditional Probability, Probability Density Function, Mean, Median, Mode and Standard Deviation, Random Variables, Discrete and Continuous Distributions, Exponential, Poisson, Normal and Binomial Distribution, Correlation and Regression Analysis.

**Numerical Methods:** Solutions of Non-Linear Algebraic Equations, Single and Multi-Step Methods for Differential Equations.

**Instrumentation Engineering****Section 2: Electricity and Magnetism**

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

**Section 3: Electrical Circuits and Machines**

Voltage and current sources: independent, dependent, ideal and practical; V-I relationships of resistor, inductor, mutual inductance and capacitor; transient analysis of RLC circuits with DC excitation

Kirchoff's laws, Mesh and Nodal analysis, Superposition, Thevenin's Norton's, maximum power transfer and reciprocity theorems.

Peak, Average and RMS values of AC quantities; apparent, active and reactive powers, Phasor analysis, Impedance and admittance, Series and parallel resonance, Locus diagrams, Realization of basic filters with R, L and C elements. transient analysis of RLC circuits with AC excitation.

One-port and two-port networks, driving point impedance and admittance, open-, and short circuit parameters.

Single phase transformer: Equivalent circuit, Phasor diagram, Open circuit and Short circuit tests, Regulation and efficiency; Three phase induction motors: Principle of operation, Types, performance, Torque-speed characteristics, No-load and blocked rotor tests, Equivalent circuit, Starting and speed control; Types of losses and efficiency calculations of electric machines.

**Section 4: Transducers, Mechanical Measurement and Industrial Instrumentation:** Resistive, Capacitive, Inductive and Piezoelectric Transducers, Hall effect sensors and their Signal Conditioning. Measurement of Displacement, Velocity and Acceleration (Translational and Rotational), Force, Torque, Vibration and Shock. Measurement of Pressure, Flow, Temperature and Liquid Level. Measurement of Ph, Conductivity, Viscosity and Humidity.

**Section 5: Analog Electronics:** Characteristics of Diode, BJT, JFET and MOSFET. Diode Circuits. Transistors at Low and High Frequencies, Amplifiers: Single and Multi-Stage, Feedback Amplifiers. Operational Amplifiers, Characteristics and Circuit Configurations. Instrumentation Amplifier. Precision Rectifier. V-To-I and I-To-V Converter. OP-Amp Based Active Filters. Oscillators and Signal Generators.

**Section 6: Digital Electronics:** Combinational Logic Circuits, Minimization of Boolean Functions, IC Families, TTL, MOS and CMOS. Arithmetic Circuits. Comparators, Schmitt Trigger, Timers and Mono-Stable Multi-Vibrator, Sequential Circuits, Flip-Flops, Counters, Shift Registers. Multiplexer, S/H Circuit. Analog to-Digital and Digital-to-Analog Converters. Basics of Number System. Microprocessor Applications, Memory and Input-Output Interfacing, Microcontrollers.

**Section 7: Signals, Systems and Communications:** Periodic and Aperiodic Signals, Impulse Response, Transfer Function and Frequency Response of First- and Second Order Systems, Fourier Transform, Laplace Transform, Sampling Theorem, Z-Transform, Convolution, Correlation and Characteristics of Linear Time Invariant Systems. Discrete Time System, Impulse and Frequency Response. Pulse Transfer Function, Ideal filters: LPF, HPF, BPF, BSF, Amplitude and Frequency Modulation and Demodulation. Pulse Code Modulation. Frequency and Time Division Multiplexing. Amplitude Shift Keying, Frequency Shift Keying and Phase Shift Keying for Digital Modulation.

**Section 8: Electrical and Electronic Measurements:** Static and Dynamic Characteristics of Measurement Systems. Error and Uncertainty Analysis, Bridges and Potentiometers, Measurement of R, L and C. Measurements of Voltage, Current, Power, Power Factor and Energy. AC & DC Current Probes. Extension of Instrument Ranges. Q-Meter and Waveform Analyzer. Digital Voltmeter and Multi-Meter. Time, Phase and Frequency Measurements. Cathode Ray Oscilloscope. Serial and Parallel Communication. Shielding and Grounding.

**Section 9: Control Systems and Process Control:** Feedback Principles. Signal Flow Graphs. Transient Response, Steady-State-Errors. Stability analysis using Routh and Nyquist Criteria. Bode Plot, Root Loci. Time Delay Systems. Phase and Gain Margin. State Space Representation of Systems. Mechanical, Hydraulic and Pneumatic

System Components. Synchro Pair, Servo and Step Motors. on-off, Cascade, P, PI, PID, Feed Forward and Derivative Controller, Fuzzy Controllers.

**Section 10: Analytical, Optical and Biomedical Instrumentation:** Mass Spectrometry. UV, Visible and IR Spectrometry. X-Ray and Nuclear Radiation Measurements. Optical Sources and Detectors, LED, Laser, Photo-Diode, Photo-Resistor and their Characteristics. Interferometers, Applications in Metrology. Basics of Fiber Optics. Biomedical Instruments, EEG, ECG and EMG. Ultrasonic Transducers and Ultrasonography. Principles of Computerized Tomography (CT) & Generations of CT.

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