GATE
Electrical Engineering

Complete Syllabus — Sections 1 to 10

Engineering Mathematics • Electric Circuits • Electromagnetic Fields • Signals & Systems • Electrical Machines • Power Systems • Control Systems • Measurements • Analog & Digital Electronics • Power Electronics

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Section 1 Engineering Mathematics

Linear Algebra	Matrix Algebra, Systems of linear equations, Eigen values, 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 integral, Surface integral, Volume integral, Stokes's theorem, Gauss's theorem, Divergence theorem, Green's theorem.
Differential equations	First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's equation, Euler's equation, Initial and boundary value problems, Partial Differential Equations, Method of separation of variables.
Complex variables	Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor series, Laurent series, Residue theorem, Solution integrals.
Probability and Statistics	Sampling theorems, Conditional probability, Mean, Median, Mode, Standard Deviation, Random variables, Discrete and Continuous distributions, Poisson distribution, Normal distribution, Binomial distribution, Correlation analysis, Regression analysis.

Section 2 Electric Circuits

Network elements	Ideal voltage and current sources, dependent sources, R, L, C, M elements.
Network solution methods	KCL, KVL, Node and Mesh analysis.
Network Theorems	Thevenin's, Norton's, Superposition and Maximum Power Transfer theorem.
Other topics	Transient response of DC and AC networks, sinusoidal steady-state analysis, resonance, two port networks, balanced three phase circuits, star-delta transformation, complex power and power factor in AC circuits.

Section 3 Electromagnetic Fields

Electrostatics	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.

Magnetostatics	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 4 Signals and Systems

Core topics	Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Fourier series representation of continuous and discrete time periodic signals, sampling theorem.
Transforms	Applications of Fourier Transform for continuous and discrete time signals, Laplace Transform and Z transform.
Waveform analysis	R.M.S. value, average value calculation for any general periodic waveform.

Section 5 Electrical Machines

Single phase transformer	Equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency.
Three-phase transformers	Connections, vector groups, parallel operation; Auto-transformer, Electromechanical energy conversion principles.
DC machines	Separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of DC motors.
Three-phase induction machines	Principle of operation, types, performance, torque-speed characteristics, no-load and blocked-rotor tests, equivalent circuit, starting and speed control; Operating principle of single-phase induction motors.
Synchronous machines	Cylindrical and salient pole machines, performance and characteristics, regulation and parallel operation of generators, starting of synchronous motors; Types of losses and efficiency calculations of electric machines.

Section 6 Power Systems

Generation & transmission	Basic concepts of electrical power generation, AC and DC transmission concepts, Models and performance of transmission lines and cables.
Operation & economics	Economic Load Dispatch (with and without considering transmission losses), Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities.

Load flow	Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction.
Faults & protection	Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential, directional and distance protection; Circuit breakers.
Stability	System stability concepts, Equal area criterion.

Section 7 Control Systems

Modelling	Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs.
Analysis	Transient and Steady-state analysis of linear time invariant systems, Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci.
Compensators & controllers	Lag, Lead and Lead-Lag compensators; P, PI and PID controllers.
State space	State space model, Solution of state equations of LTI systems.

Section 8 Electrical and Electronic Measurements

Core topics	Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi-meters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

Section 9 Analog and Digital Electronics

Diode circuits	Simple diode circuits: clipping, clamping, rectifiers.
Amplifiers & oscillators	Amplifiers: biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; Amplifiers: characteristics and applications.
Filters & converters	Single stage active filters, Active Filters: Sallen Key, Butterworth, VCOs and timers, combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits, A/D and D/A converters.

Section 10 Power Electronics

Devices	Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT.
DC-DC conversion	DC to DC conversion: Buck, Boost and Buck-Boost Converters.
Rectifiers	Single and three-phase configuration of uncontrolled rectifiers; Voltage and Current commutated Thyristor based converters; Bidirectional AC to DC voltage source converters.
Harmonics & PF	Magnitude and Phase of line current harmonics for uncontrolled and thyristor based converters; Power factor and Distortion Factor of AC to DC converters.
Inverters	Single-phase and three-phase voltage and current source inverters, sinusoidal pulse width modulation.