

## Electrodynamics, Examination syllabus

1. Basic concepts of electrostatics. Electric charge. Fundamental building blocks of matter. Electric field intensity. The superposition principle. Force between point charges, Coulomb's law. Potential difference between two points.
2. Potential at an arbitrary point. The first law of electrostatics, integral and differential form. Equipotential surfaces. Electric field and potential due to a point charge. Electric dipole. Torque acting on a point like dipole. Polar molecules and non-polar molecules. Electric polarization vector. Electric induction vector. First approximation.
3. Field lines of induction. Electric flux. Gauss's law of electrostatics, integral and differential form. Volume-, surface-, and line charge density. Poisson equation and solution. Boundary conditions.
4. Conductors in electrostatic field. Capacitance of an isolated conductor. Capacitance of an isolated conductor sphere. Capacitors. Parallel plate capacitor. Capacitors in parallel, capacitors in series. Energy storage in electric field. Energy density in electric field.
5. Current and current density. Current density in a metallic conductor. The drift speed of charge carriers. Conservation of charge, continuity equation, integral and differential form. Electromotive force. Extraneous forces, seat of emf.
6. Stationary electric field. Boundary conditions. Differential form of Ohm's law. Electrical conductivity and resistivity. Integral form of Ohm's law. Resistance of a homogeneous thin resistor. Resistivity temperature dependence. Ohm's law for a simple closed circuit. Terminal potential difference.
7. Multiloop circuits and Kirchoff's rules. Problem solving strategy. Applications of Kirchoff's rules: series-, parallel connection, potential divider, broaden the range of ammeter, voltmeter, Wheatstone bridge. Work and power in stationary current circuit.
8. Basic magnetic phenomenon. Introduction of magnetic induction by Ampere's force. Lorentz's force. Cyclotron. Torque acting on a plane current loop. Magnetic dipole momentum of a current loop.
9. Lines of magnetic induction. Gauss's law for magnetism, integral and differential form. Magnetic dipole moment of electrons. Magnetization vector. Introduction of magnetic field strength vector. The first approximation. Magnetic properties of materials. Paramagnetism, diamagnetism, ferromagnetism. Hysteresis curve. Barkhausen effect. Curie temperature.
10. Ampere's law for magnetic field, integral and differential form. Boundary conditions. Magnetic field due to a long solenoid. Biot-Savart law for a current element. Electromagnetic induction due to motion of conductor. Neumann's law. Flux rule. Emf induced by a rotating coil.
11. Induction due to change of flux linkages. Mutual-, self induction. Faraday's law of induction, integral and differential form. Self inductance of a long solenoid. Mutual inductance of two closely wound coils. Generalization of loop theorem. Energy in an inductor, magnetic energy density.
12. Forced electrical oscillation in a serial RLC circuit. The complex representation. Complex and real impedance. Complex Ohm's law. Instantaneous voltages across the different circuit element. Phasor diagram. Effective or root-mean-square value. Power in alternating current circuit.
13. The Ampere-Maxwell equation, differential and integral form. Displacement current density. Comparison of conduction and displacement current density. The Maxwell's equation. Constitutive equations.
14. Electromagnetic waves. Wave equation in homogeneous isotropic insulator. Travelling plane wave solution. Phase velocity.
15. Concept of wave front. Monochromatic wave. Wavelength wave number vector. Transverse wave. Propagation of energy in electromagnetic waves. The Poynting vector or energy current density. Intensity.
16. Interference phenomenon. Interference term. Conditions of interference. Coherent waves. Behaviour of waves at the interface of two media. Reflection and refraction. Ray concept. Snell's law. Absolute and relative refractive index. Dispersion.