**UNIT - 1 (ELECTROSTATICS)**

**Electric Charge and Field**

1. State and Explain Coulomb's law in electrostatics. Express the same in SI units
2. State and Explain superposition principle for electric forces.
3. Obtain expression for electric field intensity due to a point charge
4. Find the expression for the electric field intensity at any point on the axis of a uniformly charged ring or hoop. What happens if the ring is far away from the point.
5. Explain the term electric dipole and dipole moment. Derive an expression for electric field intensity at any point on the axial line of the dipole.
6. What is an electric dipole? Derive an expression for the electric field intensity at any point on the equatorial line of the dipole?
7. Derive an expression for the torque acting on an electric dipole placed in a uniform electric field.
8. Derive an expression for potential energy of an electric dipole placed in a uniform electric field.
9. Derive an expression for work done in rotating an electric dipole through angle θ in a uniform electric field.

**Electric potential and Flux**

1. Derive an expression for potential at a point due to a point charge.
2. Derive an expression for potential at a point due to an electric dipole.
3. Derive an expression for potential energy of a system of two charges.
4. State and prove Gauss's theorem in electrostatics.
5. Derive Coulomb's law from Gauss's theorem.
6. Using Gauss's law, derive an expression for electric field intensity at a point due to (i) a line of charge (ii) a uniformly charged spherical shell
7. Using Gauss's law, derive an expression for electric field intensity at a point due to (i) uniformly charged solid sphere (ii) an infinite plane sheet of charge
8. Derive an expression for work done in moving a charge in an electric field.

**Capacitance**

1. Derive an expression for the capacitance of a parallel plate air capacitor.
2. Derive an expression for the capacitance of a spherical capacitor.
3. What is the effect of introducing (i) a conducting slab (ii) a dielectric slab between the plates of a parallel plate capacitor on the capacitance of the capacitor.
4. Three capacitors C1, C2 and C3 are connected in series and then in parallel. Derive an expression for the equivalent capacitance respectively.
5. Derive an expression for the capacitance of a cylindrical capacitor.
6. Derive an expression for the energy stored in a parallel plate capacitor.
7. Derive an expression for the energy density of electric field.
8. Derive an expression for the capacitance of a parallel plate capacitor having a conducting slab between the plates.
9. Derive an expression for the capacitance of a parallel plate capacitor having a dielectric slab between the plates.
10. Explain the behaviour of non-polar and polar dielectrics in an electric field.

**UNIT - II (CURRENT ELECTRICITY)**

**Electric Current and Resistance**

1. Explain (i) electric current and (ii) electromotive force
2. Explain (i) drift velocity, (ii) relaxation time of free electrons in a metallic conductor carrying current. Establish a relation between then.
3. Derive the relation between electric current and drift velocity of free electrons in a metallic conductor
4. Explain Ohm's law. How will you prove its validity?
5. Explain the terms (i) resistance (ii) resistivity (iii) conductance (iv) charge mobility
6. Find the total resistance when three resistors of resistance R1, R2 and R3 are connected (i) in series (ii) in parallel
7. How does resistivity vary with temperature in case of (i) conductors, (ii) semi conductors (iii) insulators
8. Derive an expression for the circuit current when a number of cells connected in (i) series (ii) parallel
9. Find the condition for maximum current in the external resistor in case of (i) series grouping of cells (ii) parallel grouping of cells
10. Find the condition for maximum current in the external resistor for mixed grouping of cells

**Electrical Measurements**

1. State and explain Kirchhoff's laws of electric circuits
2. With a neat diagram, explain the working of Wheatstone bridge
3. Explain the principle and working of potentiometer
4. How can you measure the e.m.f of a cell by potentiometer?
5. Explain how is the potential difference across a resistor measured by a potentiometer?
6. How will you compare the e.m.f's of two cells by a potentiometer?
7. Describe the method to measure the internal resistance of a cell by potentiometer
8. Describe the construction and working of slide wire bridge.
9. Write a short note on (i) principle of Wheatstone bridge (ii) principle of potentiometer

**UNIT III (MAGNETIC EFFECTS of CURRENT and MAGNETISM)**

**Magnetic Field Due to Electric Current**

1. State Biot-Savart law. Using Biot-savart law, find the expression for the magnetic field at the centre of a circular coil having number of turns *n*, radius *r* and carrying current *I.*
2. Using Biot-Savart law, derive an expression for the magnetic field at a point on the axis of a circular coil carrying current.
3. Using Biot-Savart law, derive an expression for the magnetic field at a point due to current flowing through a straight conductor.
4. State and prove Ampere's circuital law.
5. Using Ampere's circuital law, derive an expression for the magnetic field due to current in a toroid.
6. Using Ampere's circuital law, obtain an expression for the magnetic field at a point well inside the solenoid carrying current.
7. Define magnetic field in terms of force acting on a charge moving in a magnetic field. Give the SI unit and dimensional formula of

**Motion of Charged Particle in Electric and Magnetic Fields**

1. Show that the path of a charged particle moving in uniform electric field with initial velocity perpendicular to the field is parabolic in the electric field.
2. Show that the path of a charged particle moving in a uniform magnetic field with initial velocity perpendicular to the field is circular in the magnetic field.
3. Show that the path of a charged particle moving in a uniform magnetic field with initial velocity making an angle θ to the direction of the field is helical in the magnetic field.
4. Describe the principle, construction and working of a cyclotron.
5. Describe the principle, construction and working of a moving coil galvanometer.
6. Derive an expression for the torque acting on a rectangular current carrying loop placed in a uniform magnetic field.
7. Explain how to convert a galvanometer into (i) an ammeter (ii) a voltmeter ?
8. Write a short note on (i) uses of shunt (ii) advantages of a moving coil galvanometer
9. Define current and voltage sensitivity of a galvanometer. Suggest methods to improve the sensitivity of a galvanometer.
10. Find the expression for the force acting on a current carrying conductor placed in a uniform magnetic field.
11. Derive an expression for the force acting between two long straight parallel conductors carrying currents in the same direction.
12. Derive an expression for maximum force experienced by a straight conductor carrying current when placed in a uniform magnetic field.

**Magnets and Earth's Magnetism**

1. What is magnetic field? Give the important properties of magnetic lines of forces.
2. Derive an expression for the magnetic field at a point on the axial line of a magnetic dipole.
3. Derive an expression for the magnetic field at a point on the equatorial line of a magnetic dipole.
4. Derive an expression for the torque acting on a bar magnet held at an angle with the direction of magnetic field.
5. Find the potential energy of a magnetic dipole in a uniform magnetic field.
6. Show that a current loop behaves as a magnetic dipole. What is the significance for its magnetic moment?
7. What is Gauss's law in magnetism? Explain its significance?
8. Give three evidences in support of earth's magnetism? What is the cause of earth's magnetism?
9. Explain the three magnetic elements of earth's magnetic field at a place.

**Classification of Magnetic Materials**

1. Explain the terms (i) magnetic flux (ii) magnetic induction (iii) relative permeability and (iv) magnetic intensity.
2. What are diamagnetic and paramagnetic materials? Write three properties to distinguish their characteristics.
3. Discuss the important properties of diamagnetic, paramagnetic and ferromagnetic materials
4. What are ferromagnetic substances? Explain domain theory of ferromagnetism.
5. What is hysteresis? Explain the *B - H* curve of a ferromagnetic material.
6. Define retentivity and coercivity. What is their importance in ferromagnetic substances?
7. Sketch the hysteresis loops of soft iron and steel. What conclusions you draw from these loops?
8. Which magnetic material is used for making (i) electromagnets (ii) permanent magnets (iii) cores of transformers? Give reasons.

**UNIT IV (ELECTROMAGNETIC INDUCTION & ALTERNATING CURRENTS)**

**Electromagnetic Induction**

1. What is electromagnetic induction? State and explain Faraday's laws of electromagnetic induction.
2. State and explain Lenz's law. Show that this law is in accordance with the law of conversation of energy.
3. Derive an expression for induced e.m.f. developed in a conductor of length ***l*** moving with velocity ***v*** normal to a uniform magnetic field of strength ***B***
4. Explain the phenomenon of self induction. Derive an expression for self induction of a long solenoid.
5. Explain the phenomenon of mutual induction. Derive an expression for coefficient of mutual inductance between two long solenoids.
6. What are eddy currents? Give five useful applications of eddy currents.
7. What are eddy currents? Explain how these are minimised. Give three useful applications of eddy currents.
8. Give two alternate definitions of (i) self inductance of a coil (ii) mutual inductance of two coils.
9. Two coils of self inductances L1 and L2 are connected in series. If current in them flows in the same sense and they have a mutual inductance M, what is their equivalent inductance?

**Alternating Currents**

1. What is meant by average value of an alternating current? Derive an expression for average value of a.c. over the half cycle.
2. Define root mean square value of alternating current. Derive an expression for the root mean square value of alternating current.
3. An a.c. voltage E=E0 sin ωt is applied across an inductor L. Obtain the expression for current and power absorbed

(or)

Find the phase relation between current and e.m.f. if an a.c. circuit contains a pure inductor. Prove that a high frequency a.c. cannot pass through a pure inductor.

1. An a.c. voltage E=E0 sin ωt is applied across a pure capacitor. Obtain the expression for current and power absorbed

(or)

Find the phase relation between current and e.m.f. if an a.c. circuit contains a pure capacitor. Prove that a d.c. cannot pass through a capacitor.

1. Find the expression for (i) current (ii) power absorbed in an a.c. R - L series circuit.
2. Find the expression for (i) current (ii) power absorbed in an a.c. R - C series circuit.
3. What is impedance triangle? What is its importance? Draw impedance triangle for an a.c. R - L series circuit.
4. An a.c. voltage E=E0 sin ωt is applied to a series combination of R, L and C. Using phasor diagram, find expression for (i) impedance of the circuit (ii) phase angle between circuit current and applied alternating e.m.f.
5. What is electrical resonance? Derive an expression for the frequency of a series resonant circuit. What is Q factor of this circuit?
6. Derive expression for power absorbed in (i) a pure resistor (ii) pure inductance.
7. Derive an expression for power absorbed in LCR series circuit connected to a.c. supply.

**Transformer and Generator**

1. Derive an expression for the e.m.f. produced in a coil rotating with a constant angular velocity in a uniform magnetic field.
2. Explain the principle, construction and working of an a.c. generator.
3. Explain the principle, construction and working of a transformer.
4. Explain the uses of a transformer.

**Unit V (Electromagnetic waves)**

1. State and explain Maxwell's modification of Ampere's law. (or)

What is displacement current? Show that the conduction and displacement currents are individually discontinuous but their sum is continuous.

1. What is an electromagnetic wave? Show that electromagnetic waves are transverse in nature.
2. What do you understand by electromagnetic waves? Give their properties
3. Find the relation for the velocity of electromagnetic waves.

Prove that for a electromagnetic wave (i) E0 = cB0 (ii) c = 1/

1. Explain Hertz experiment for the generation of electromagnetic waves.
2. Name the parts of an electromagnetic spectrum giving their frequency range and source of production in each case.
3. Give three uses of (i) X - rays (ii) Microwaves (iii) Ultraviolet rays (iv) radio waves (v) infrared rays
4. State the uses of electromagnetic waves.