Answer all questions. Each question carries equal mark.

1. (a) Find the electric field at a point on the axis of a uniformly charged ring of radius 'a' at a distance 'x' from its centre. 2
   (b) Two equal positive charges $q_1 = q_2 = 2\mu C$ are located at x = 0, y = 0.3m and x=0, y= – 0.3m, respectively. What are the magnitude and direction of the total electric force that q_1 and q_2 exert on a third charge $Q = 4\mu C$ located at x = 0.4m, y = 0 2
   (c) An electric dipole is placed in a region of uniform electric field E, with the electric dipole moment p, pointing in the direction opposite to E. Is the dipole (i) in stable equilibrium (ii) in unstable equilibrium (iii) neither? Justify. 2

2. (a) A charged non-conducting sphere of radius R has a total positive charge q. Find the electric field at any point inside the sphere. 2
   (b) A solid non-conducting sphere with radius ***0.45 m*** carries a net charge of ***0.25nC***. Find the magnitude of the electric field at a point ***0.1 m*** inside and outside the surface of the sphere. 2
   (c) A closed Gaussian surface encloses five discrete charges of **+5μC, 3μC, +8μC, +1μC and -10μC**. Find the electric flux through it. 2

3. (a) Derive an expression for electric field in terms of potential gradient. 2
   (b) A small particle has charge – 5 μC and mass 2×10^{-4}kg. It moves from point 'A' where the electric potential is $V_A = +200$V, to point 'B' where the electric potential is $V_B = +800$V. The electric force is the only force acting on the particle. The particle has speed 5m/s at point 'A'. What is its speed at point 'B'? Is it moving faster or slower at 'B' than at 'A'? Explain. 2
   (c) If the electric potential at a certain point is zero, does the electric field at that point have to be zero? 2

4. (a) Find the capacitance of a parallel plate capacitor with its two plates each of area A at a distance d from each other. What change in its capacity do you expect if a dielectric is inserted between the plates? 2
   (b) The plates of a parallel-plate capacitor in vacuum are 5mm apart and $2m^2$ in area. A 10kV potential difference is applied across the capacitor. Compute (a) the capacitance; (b) the charge on each plate; and (c) the magnitude of the electric field between the plates. 2
   (c) A capacitor has vacuum in the space between the conductors. If you double the amount of charge on each conductor, what happens to the capacitance? Justify your answer. 2

5. (a) Express Ohm's Law in terms of electric field and current density. Hence derive the relation between potential difference across a conductor and the current flowing through it. 2
   (b) A radio receiver operating at 6 V draws a current of 0.1 A. How much electrical energy will it consume in 2 hours? 2
   (c) What shunt resistance is required to convert a ***1 mA, 20 Ω*** galvanometer into ammeter of range ***0*** to ***50mA***? 2

6. (a) A charged capacitor of capacitance C is discharged through a resistor of resistance R. Obtain the expression for instantaneous charge on the capacitor during discharging. 2
   (b) A 10 MΩ resistor is connected in series with a 1.0 μF capacitor. The capacitor has an initial charge of 5.0 μC and is discharged by closing the switch at t = 0. (a) At what time will the charge on the capacitor plate be equal to 0.50 μC? (b) What is the current at this time? 2
   (c) Show graphically the variation of charge q and current i with time when the charged capacitor is being discharged in RC circuit. 2

7. (a) Evaluate the force on a current carrying conductor in a magnetic field. 2
   (b) A straight horizontal copper rod carries a current of 50A from west to east in a region between the poles of a large electromagnet. In this region there is a horizontal magnetic field toward the northeast (that is, 45° north of east) with magnitude 1.20 T. Find the magnitude and direction of the force on a 1.00-m section of rod. 2
   (c) If you double the speed of the charged particle in a magnetic field while keeping the magnetic field, charge and mass constant, how does this affect the radius of the trajectory and time required to complete one circular orbit. 2

8. (a) State Ampere's circuital law and express its modified form with help of displacement current. 2
   (b) The electric flux through a certain area of a dielectric is ***(8.76×10^3 Vm/s^4) t^4***. The displacement current through the area id ***12.9pA*** at time ***$t = 26.1$ms***. Calculate the dielectric constant for the dielectric. 2
   (c) Graphically, show the variation of magnetic field with distance 'r' from the axis of a cylindrical conductor carrying current, both inside and outside the conductor. 2

9. (a) Express the instantaneous current in an R-L circuit when there is growth of current. Explain it graphically. 2

(b) An oscillating voltage of fixed amplitude is applied across a circuit element. If the frequency of this voltage is increased, will the amplitude of the current through the element (i) increase (ii) decrease or (iii) remains the same if it is (i) resistor and (ii) an inductor. 2

(c) A series L-C-R circuit comprises of a L=60mH, C=0.50μF, R=300Ωare connected to an ac source of voltage V=50 volt and ω=10000 rad/s. Find (i) impedance of the circuit and (ii) expression of current. 2

10 (a) Write the key features of electromagnetic wave. 2

(b) For an electromagnetic wave propagating through free space, calculate the frequency of a wave, with a wavelength of (a) 30 Å; (b) 300 Å; (c) 3000 Å and (d) 30 m. 2

(c) Express the Maxwell's electromagnetic equations which are not changed in the presence of charges and currents. 2

End of Questions