End-Semester Examination, July-2015
UPEM

Full Marks: 60 **Time: 3 Hours**

Questions in Group-A are compulsory. Answer two questions from Group-B, two questions from group-C and one question from Group-D. Answer all parts of a question at one place only. The figures in the right hand margin indicate marks.

GROUP – A (Answer All) 1x10

1. (a) What is the magnitude of electric field E at a point 2.0 m from a point charge q = 4.0 nC?
   (b) What is the magnitude and direction of dipole moment of an electric dipole?
   (c) A wire of 20Ω resistance is stretched to twice its original length. What will be its new resistance?
   (d) What is the difference between electron volt and volt?
   (e) What is the significance of 'time constant' of R-C circuit?
   (f) A particle with charge 'q' is moving inside an uniform magnetic field B with a velocity 'v' perpendicular to the direction of magnetic field. What will be the trajectory of the particle? Justify your answer.
   (g) Write down the Maxwell's equation which explains non-existence of magnetic monopole.
   (h) Calculate the work done in taking charge particle ($q = 3.2 \times 10^{-12}$ C) through a distance x = 2.0cm on a equipotential surface of 10V.
   (i) When two capacitors of equal capacitance are connected in series and parallel. Find out the value of equivalent capacitance in above connection.
   (j) If a varying current is passed through a coil, then what will be the magnitude of the self inductance of the coil?

GROUP – D (Answer any one)

8. (a) A small particle has a charge -5μC and mass 2.00×10^{-4}kg. It moves from point A, where the electric potential is V_A = +200V to point B, where the electric potential is V_B = +800V. The electric force is the only force acting on the particle. The particle has speed 5.00 m/s at point A. What is its speed at point B?. Is it moving faster or slower at B than at A? Explain. 5
   (b) The combination of two capacitors of capacitance 4μF & 6μF are connected in series is connected to a battery. If the voltage across the 4-μF capacitance is 3V, find the terminal voltage across the battery. 5

9. (a) A circular coil 0.05 *m* in radius, with 30 *turns* of wire, lies in a horizontal plane. It carries a counterclockwise current of 5 *A*. The coil is in a uniform 1.2 *T* magnetic field directed toward the right. Find the magnitude of the magnetic moment and the torque on the coil. 5
   (b) A 20-μF capacitor is charged by a 150-V power supply, then disconnected from the power and connected in series with a 0.28-mH inductor. Calculate 5
   (i) the oscillation frequency of the circuit,
   (ii) the energy stored in the capacitor at the moment of connection with the inductor i.e t = 1.3 s

End of Questions

GROUP – B (Answer any two)

2. (a) Derive an expression for the torque on an electric dipole placed in a uniform electric field. Hence define electric dipole moment. 7

   (b) Two point charges $+q$ and $+4q$ are separated by a distance of 6 cm. Find the point on the line joining the two charges where the resultant electric field is zero. 3

3. (a) Using Gauss's law, calculate the electric field due to uniformly charged long straight conductor of linear charge density $\lambda\ Cm^{-1}$ at a distance r from its axis. 7

   (b) An electric dipole of dipole moment $2.5 \times 10^{-5}\ Cm$ is enclosed by a closed surface. What is the net flux coming out of the surface? 3

4. (a) Find an expression for the energy stored in a parallel plate capacitor of capacitance C when it is charged to the final charge Q_f & hence find energy density in between the plates. 7

   (b) The pates of a parallel-plate capacitor in vacuum are 5.00 mm apart and in 2.00 m^2 area. A10.0-kV 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. 3

GROUP – C (Answer any two)

5. (a) What is drift velocity of electron inside a conductor? Derive the expression for the drift velocity of electron and conduction current in a conductor when electric field is applied across the conductor. 7

   (b) A beam of electrons moves at 3×10^5 m/s through a uniform 2.0 T magnetic field directed along the positive z- axis. The velocity of each electron lies in the xz-plane and is directed at 30^0 to the +z axis. Find the force on an electron. 3

6. (a) Derive expression for instantaneous charge and current in a R-C circuit when the capacitor is being charged and discuss graphically the growth of charge and decay of current in the process. 7

   (b) A long, straight conductor carries a 1.0-A current. At what distance from the axis of the conductor does the resulting magnetic field have magnitude $B = 0.5 \times 10^{-4}$ T? 3

7. (a) What is displacement current? How the concept of the displacement current used by Maxwell to modify the Ampere's circuital law. 7

   (b) Two straight, parallel, superconducting wires 4.5 mm apart carry equal currents of 15,000A in opposite directions. What force, per unit length, does each wire exert on the other? 3