[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 2917 **H**

Unique Paper Code : 32221201

Name of the Paper : Electricity and Magnetism

Name of the Course : **B.Sc. (Hons) Physics (CBCS-LOCF)**

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. **1** is compulsory.
3. Answer any **four** of the remaining **six** questions.

1. Attempt all parts of this question: (5×5=25)

   (a) Two charges each of 2μC but opposite in sign are 1 cm apart. Calculate electric field at a point distant 10 cm from the mid-point on axial line of the dipole.

   (b) Prove that electrostatic forces are conservative in nature.

P.T.O.

(c) Show that $\vec{\nabla}.\vec{B}=0$. What is its physical significance?

(d) State Faraday's laws of Electromagnetic Induction. The magnetic flux threading a coil change from 12×10^{-3} to 6×10^{-3} Wb in 0.01 seconds. Calculate the induced e.m.f.

(e) Explain superposition theorem with an example of your choice.

2. (a) What is Gauss law? Using Gauss law to find the expression for electric field due to uniformly charged sphere at

(i) Point outside the charged sphere.

(ii) Point inside the charged sphere. (6)

(b) Obtain an expression for magnetic field due to a straight line conductor carrying current I. Calculate the magnetic field induction at the center of a coil bent in the form of a square of side 10 cm carrying a current of 10 A. (4,2.5)

3. (a) If the electrostatic potential is $V = a/(x^2 + y^2 + z^2)^{1/2}$, show explicitly that it satisfies Laplace equation. (6.5)

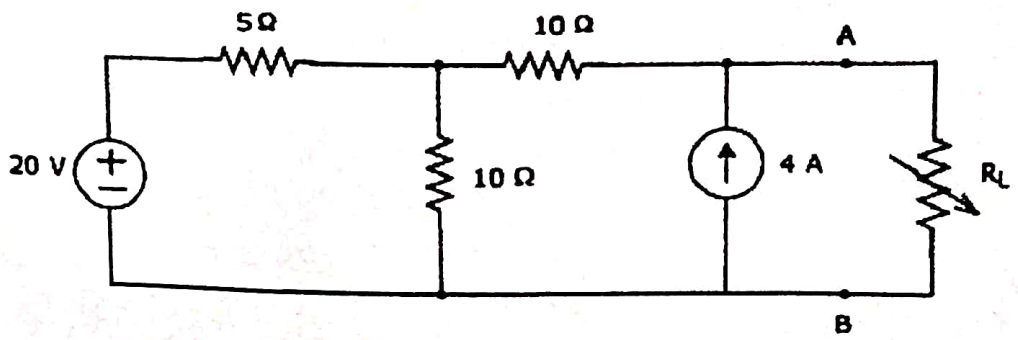
(b) What is residual magnetism of a material? A magnetizing field of 1600 A/m produces a magnetic flux of 2.4×10^{-5} Wb in a bar of iron of cross section 0.2 cm^2. Calculate magnetic permeability and susceptibility of the bar. (2,4)

4. (a) Obtain the expressions for capacity of parallel plate capacitor when filled with i) conducting slab of thickness t between the plates ii) dielectric slab of thickness t between the plates. (6.5)

(b) A sinusoidal voltage of peak value 70V and frequency 50Hz is applied to a series LCR circuit in which R = 3Ω, L = 25mH and C= 796μF. Find (i) The impedance of the circuit (ii) phase difference between voltage across the source and current (iii) the power dissipated in the circuit and (iv) the power factor. (6)

5. (a) Using the method of images, obtain the expressions for potential and field due to point charge placed near conducting sphere which is earthed. (6)

(b) Find the value of R_L for maximum power transfer in the circuit given : (3,3.5)

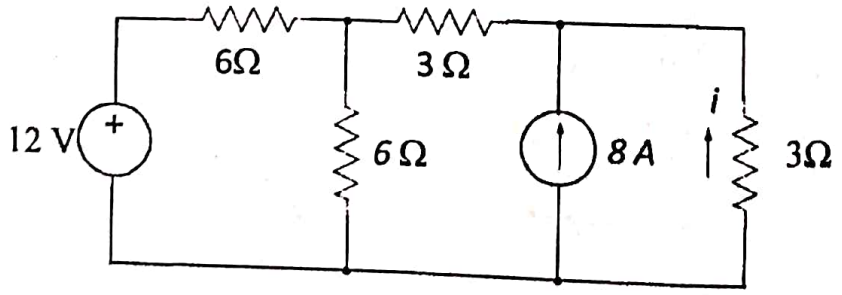


6. (a) The space between two concentric spherical shells (radii a, b) of a spherical capacitor is filled with the dielectric material of relative permittivity $\epsilon_r = \frac{k}{r}$, where k is a constant. Find the capacitance of the capacitor. (6)

(b) Derive an expression for self-inductance of a long solenoid. A coil of wire of certain radius has 600 turns and a self-inductance of 108 mH. What will be self-inductance of a similar coil which has 500 turns. (3,3.5)

7. (a) Eight positive charges, each of magnitude q, are kept at comers of a cube of side a. Calculate the Potential energy of the system if -2q is placed at the center of the cube. (6)

(b) Use nodal analysis to find the value of 'i' for the circuit shown : (6.5)



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Your Roll No......

Sr. No. of Question Paper : 4123 **H**

Unique Paper Code : 2222011202

Name of the Paper : Electricity and Magnetism

Name of the Course : **B.Sc. (H) – DSC**

Semester : II

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question **1** is compulsory.
3. Attempt any **four** questions from question numbers **2-6**.
4. **All** questions carry equal marks.

1. Attempt all parts of this question : (6×3=18)

   (a) Two uniform infinite sheets of electric charge densities $+\sigma$ and $-\sigma$ intersect at an angle of 45°. Find the magnitude and direction of the resultant electric field.

   (b) Calculate the charge density in an enclosed region due to the potential

   $$V = x^2 + y^2 + z^2.$$

P.T.O.

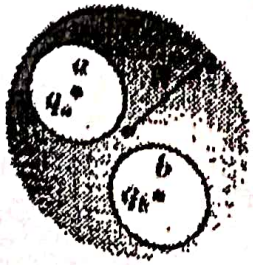
(c) Show that equation of continuity is a consequence of Maxwell's equations.

(d) Given that $\vec{E}_1 = 2\hat{i} - 3\hat{j} + 5\hat{k}$ (V/m) at the charge-free dielectric interface between two different dielectric materials of 2 and 5, respectively. Find $\vec{E}_2$ and $\vec{D}_2$.

(e) Determine whether the following elements are paramagnetic or diamagnetic (i) Chlorine Atoms (Atomic No. = 17, Atomic Mass = 35.43 u), and (ii) Copper atoms (Atomic No. = 29, Atomic mass = 63.55 u)

(f) A current sheet of width 4 m lies in the $z = 0$ plane and contains a total current of 10 A in a direction from the origin to (1, 3, 0) m. Find an expression for $\vec{K}$.

2. (a) Two spherical cavities, of radii a and b, are hollowed out from the interior of a (neutral) conducting sphere of radius R. At the center of each cavity a point charge placed q_a and q_b. Find the surface charge densities on the walls of both the cavities and the surface of the conductor. What is the force experienced by q_a and q_b? (9)



(b) A block of iron ($\mu = 5000\ \mu_0$) is placed in a uniform magnetic field with 1.5 Wb/m^2. If iron consists of 8.5×10^{28} atoms/m^3, calculate (i) the magnetization M (ii) the average dipole moment. (9)

3. (a) A point charge q is located at a from the center of a grounded conducting sphere of radius R along y axis such that (a > R). What is the potential outside the grounded conducting sphere? (9)

(b) In spherical coordinates, V = 0 for r = 0.10 m and V = 100 V for r = 2.0 m. Assuming free space between these concentric spherical shells, find E and D. (9)

4. (a) Calculate the Laplacian of electrostatic potential at any arbitrary point P due to a point charge q located at r' from the origin. (9)

(b) Is it true that in a uniform material with magnetic susceptibility χ_m and electric conductivity 0, the bound current distribution can only be a surface current (assume no time dependence). Justify. (3)

(c) Using Ampere's law obtain magnetic flux density B inside and outside the toroid. (6)

5. (a) A very long cylinder of linear dielectric material is placed in an uniform electric field E_0. Find the resulting field within the cylinder. (The radius is R, the susceptibility χ_r and the axis is perpendicular to E_0.) (9)

(b) State the second uniqueness theorem and under what condition(s) it will reduce to the first one. (3)

(c) In a material for which $\sigma = 5.0$ S/m, $\varepsilon_r = 1$ and electric field intensity is $E = 250\sin 10^{10}t$ V/m. Find the conduction and displacement current densities and the frequency at which they have equal magnitudes. (6)

6. (a) An infinitely long cylinder, of radius R, carries a "frozen-in" magnetization, parallel to the axis, $\vec{M} = kr\hat{r}$ where k is a constant and r is the distance from the axis (there is no free current anywhere). Find the magnetic field inside and outside the cylinder

(i) Locate all the bound currents, and calculate the field they produce.

(ii) Use Ampere's law to find $\vec{H}$, and then get $\vec{B}$. (3+3+3+3)

(b) Two coaxial solenoids each carrying current I, but in opposite directions. The inner solenoid of radius a has N_1 turns per unit length and the outer of radius b has N_2 turns per unit length. Find $\vec{B}$ in each of the three regions : (i) inside the inner solenoid, (ii) between them and (iii) outside the outer solenoid. (2+2+2)