



বিদ্যাসাগর বিশ্ববিদ্যালয়

VIDYASAGAR UNIVERSITY

Question Paper

B.Sc. Honours Examination 2023

(Under CBCS Pattern)

Semester — II

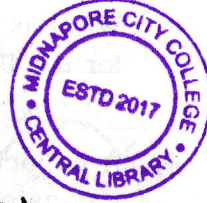
Subject : PHYSICS

Paper : C-3T

(Electricity and Magnetism)

Full Marks : 40

Time : 2 hours



*Candidates are required to give their answers
in their own words as far as practicable.*

The figures in the margin indicate full marks.

*Answer from **all** the Groups as directed.*

GROUP—A

Answer **any five** questions from the following :

2×5=10

1. In a certain region of space, the electric field is given by $\vec{E} = E_0 \sin(\omega t - kx)\hat{j}$. Find the corresponding magnetic field \vec{B} .

/682

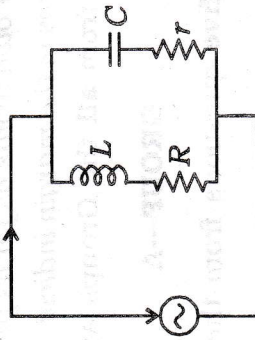
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(2)

2. Show that the vector $\vec{E} = (2xy + z^3)\hat{i} + x^2\hat{j} + 3xz^2\hat{k}$ represents electrostatic fields. Also find the corresponding electrostatic potential ϕ ; given $\phi = \phi_0$ at $x = y = z = 0$.
3. The potential of a certain electrostatic field has the form $\phi = a(x^2 + y^2) + bz^2$, where a, b are constants. Find the corresponding electric field. What is the shape of the equipotential surface for $a > 0, b < 0$?

4. A capacitor (parallel plate) is being charged at a constant rate $dq/dt = b$. If A is the area of the plates and d is separation between them, then find the displacement current.

5.



For $V = V_0 \cos \omega t$, find the resonance frequency of the circuit.

/682

(Continued)

(3)

6. Which property of \vec{B} leads to the concept of magnetic vector potential (\vec{A})? What is the unit of \vec{A} ?
7. A flat circular loop of diameter $0.2/\sqrt{\pi}$ cm carries a current of 100 mA. Calculate its dipole moment.
8. Calculate the r.m.s. value of the current $i = I_0 + I_1 \sin \omega t$.



GROUP—B

Answer any four questions from the following :

5×4=20

9. An electric dipole is suspended in a uniform electric field, which is aligned parallel to the electric field. The dipole is slightly rotated about its center and released. Show that for small angular displacement, the motion is angular simple harmonic and find its time period. 5

/682

(Turn Over)



10. (a) State and establish Gauss's law in presence of dielectric. (4)
3

(b) Consider a dielectric hemisphere with its plane surface in the $x-y$ plane. It has a polarisation $\vec{P} = Ak\hat{k}$. Find the volume and surface charge densities of polarisation charges. 2

11. (a) Find an expression for force per unit length between two parallel current carrying conductors. 2

(b) A current I flows through a wire shaped in the form of a square of side L . Determine the magnetic field at the centre of the square. 3

12. (a) Show that the equivalent inductance of two coils of self-inductances L_1 and L_2 , and mutual inductance M connected in parallel is

$$L_{eq} = \frac{L_1 L_2 - M^2}{L_1 + L_2 \mp 2M} \quad 3$$

(b) A solenoid has a diameter of 2 cm and 1000 turns wound over a length of 50 cm. Calculate the self-inductance of the solenoid. The relative permeability of the core material 100.5. 2

/682

(Continued)

13. (a) A capacitor of capacitance C is connected by leads of resistance r to a coil of inductance L and resistance R . An ac e.m.f. $E = E_0 \sin \omega t$ is now applied across the coil. (5)

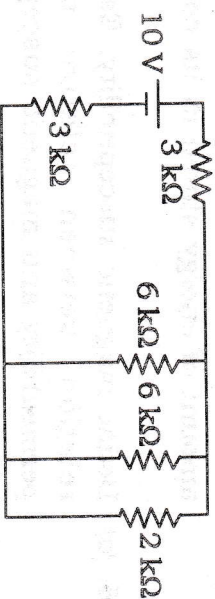
(i) Find the resonant frequency of the circuit.

(ii) Find the impedance of the circuit.

(iii) Show that the impedance of the circuit will be independent of the frequency if $R = r = \sqrt{L/C}$. 3

(b) A voltage source of internal resistance r delivers same power when connected separately to loads R_1 and R_2 . Hence show that $r = \sqrt{R_1 R_2}$. 2

14. (a) Using Thevenin's theorem, find the current through the $2 \text{ k}\Omega$ resistor of the circuit. 3



/682

(Turn Over)





(6)

- (b) A parallel plate air capacitor has the plates of area A each. Assuming that the charge Q on it is kept constant, find the work done against the electrical forces to increase the plate separation from d_1 to d_2 . 2

GROUP—C

Answer any one question from the following :

$10 \times 1 = 10$

15. (a) Obtain Maxwell's 3rd equation from Faraday's law. 2

- (b) Obtain the dimension of inductance. On which factors do the self and mutual inductances depend? 4

- (c) A toroid has mean radius 10 cm and cross-sectional radius 0.5 cm. It has 10 number of turns per cm closely wound on a nonmagnetic core ($\mu = \mu_0$). If it carries a current 10 mA, then what will be the amount of energy stored in its core? 4

16. (a) Define magnetic susceptibility. Establish a relation between relative magnetic permeability and magnetic susceptibility. 1+2=3

/682

(Continued)

(7)

- (b) If \vec{B} is uniform magnetic field, then show that magnetic vector potential is $\vec{A} = -\frac{1}{2}(\vec{r} \times \vec{B})$. Here \vec{r} is the position vector. 3

- (c) What do you mean by hysteresis in a ferromagnetic material? Show that the hysteresis loss per unit volume per cycle of magnetization is equal to the area enclosed by the B - H loop. 1+3=4

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