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2 SEM TDC PHYH (CBCS) C 3

2023

( May/June )

PHYSICS

( Core )

Paper : C–3

**( Electricity and Magnetism )**

*Full Marks* : 53
*Pass Marks* : 21

*Time* : 3 hours

*The figures in the margin indicate full marks for the questions*

**1.** Choose the correct option from the following : 1×5=5

*(a)* Electric field lines and equipotential lines are

✓*(i)* always orthogonal

*(ii)* orthogonal only when electric field is uniform

*(iii)* orthogonal only when potential does not change

*(iv)* None of the above

(b) If the free space between two plates of a capacitor is filled with dielectrics, then its capacitance will

(i) increase

(ii) decrease

(iii) not change

(iv) zero

(c) Choose the correct option :

(i) $\overline{\nabla} \times \overline{B} = 0$

(ii) $\overline{\nabla} \cdot \overline{A} = B$

(iii) $\overline{\nabla} \times \overline{B} = \mu J$

(iv) $\overline{\nabla} \times \overline{H} = \mu J$

(d) According to Faraday's law the e.m.f. is induced in the coil when

(i) the coil is stationary and flux is changing with time

(ii) the coil is moving and flux is changing with time

(iii) Both (i) and (ii)

(iv) None of the above



( Continued )



(e) In parallel resonance circuit, impedance at resonance is

(i) minimum

(ii) maximum

(iii) equal to difference of inductive and capacitive impedances

(iv) None of the above

2. (a) What is meant by electric flux? Give its SI unit. 2

(b) By applying Gauss theorem, find the electric field due to a uniformly charged thin spherical shell at an external point. 3

(c) Obtain the expression for the potential due to an electric dipole. Show that electrical potential at any point on the equatorial line of a dipole is zero. 3+1=4

3. (a) What do you mean by electrical potential energy of a system of charges? Derive an expression for it and show that energy density is given by

$$U = \frac{\varepsilon_0}{2} E^2$$

1+3=4



( Turn Over )

(b) The capacitance of a parallel-plate capacitor is 400 picofarad and the plates are separated by 2 mm of air. What will be the energy when it is charged to 1500 V? What will be the potential difference with the same charge if plate separation is doubled? 4

*Or*

Find the expression for the capacitance per unit length of capacitor consisting of two coaxial cylinders.

4. (a) Explain the term 'dielectric constant'. 1

(b) What do you understand by the polarization of dielectric? Define electric polarization vector. 1+1=2

(c) Define displacement vector ($D$). State the Gauss theorem in dielectric medium. 1+2=3

5. (a) State Ampere's circuital law and apply it to find the magnetic field at the centre of a long current-carrying solenoid. 1+3=4





(b) Calculate the magnetic force between two long straight current-carrying wires when currents are flowing in opposite direction. 3

*Or*

A wire of length 44 cm carries a current of 10 A is bent into a square. Find the magnitude of the magnetic field at the centre.

6. What do you mean by magnetic susceptibility ($\chi$) and magnetic permeability ($\mu$)? Derive the relation between them. 2+2=4

7. (a) State Lenz's law. Explain how Lenz's law establishes the law of conservation of energy. 1+1=2

*Or*

An e.m.f. of 250 V is applied to an inductor of 10 H. It has a resistance of 50 Ω. If the current attains the maximum value, then find the energy stored in the inductance. 2

(b) Calculate the mutual inductance of two concentric solenoids. 3

8. (a) Find the expression for current of an a.c. circuit containing $L$, $C$ and $R$ in series connected with a complex a.c. voltage. Under what condition, electrical resonance will occur? 3

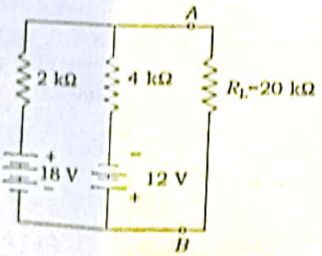
*Or*

A series $L$-$C$-$R$ circuit has $L = 0{\cdot}12$ H, $C = 480$ nF and $R = 23$ ohm and is connected to an alternating 230 volt supply. Calculate the resonance frequency and maximum current, maximum power absorbed and $Q$-factor of the circuit.

(b) State and explain superposition theorem. To which type of system, is the superposition theorem valid? 2+1=3

*Or*

Using Thevenin's theorem, calculate $V_{TH}$, $R_{TH}$ and current through the load $R_L = 20$ kΩ for the following circuit :






*( Continued )*



9. Derive a relation between the charge passing through a ballistic galvanometer and its corresponding throw. 3

*Or*

What is critical damping resistor in a ballistic galvanometer? How is a ballistic galvanometer made dead beat?

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