2016

PHYSICS

(Major)

Paper : 3.2

(Current Electricity and Magnetostatics)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer the following questions : 1×5=5

(a) The coefficient of coupling between two coils is 0·6. What does it mean?

(b) State Ampere's circuital law for steady currents.

(c) How does a current loop behave as a magnetic dipole?

(d) When does a series *L-C-R* circuit have the maximum impedance and what is its value?

(e) A transformer cannot work on d.c. Explain why.

2. Answer the following questions : 2×5=10

(a) Why is Wheatstone bridge not suitable for measurement of very low resistance?

(b) What do you mean by *Q* factor of an a.c. series resonant circuit?

(c) In a region, the force $\vec{F} = q(\vec{v} \times \vec{B})$ on a charge q is zero. What conclusions can you draw from it?

(d) Explain the differences between a 'dead-beat' galvanometer and a 'ballistic' galvanometer.

(e) Establish that

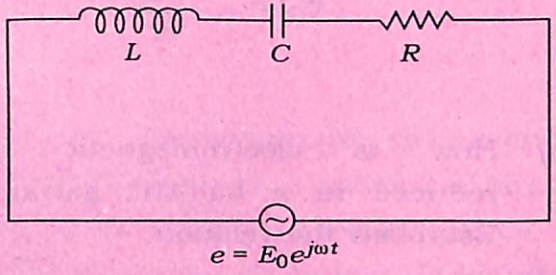
$$i = \int_S \vec{J} \cdot \hat{n}\, dA$$

where $\hat{n}$ is a unit vector normal to the area dA.

3. Answer any *three* of the following questions : 5×3=15

(a) Using Biot-Savart law, derive an expression for magnetic field at an axial point due to a circular coil.

(b) Assuming the current phasor as $i = Ae^{j\omega t}$, find an expression for complex impedance of the circuit



(c) A condenser is charged from a d.c. source through a resistance of 2×10^6 ohm. After half a second, this charge reaches three quarters of its maximum value. Find the capacity of the condenser. [Given $\log_{10} 4 = 0 \cdot 6021$].

(d) What is thermoelectric power? Considering the electromotive force (e) as

$$e = \pi_2 - \pi_1 - \int_1^2 (\sigma_A - \sigma_B)\, dT$$

find an expression for thermoelectric power.

(e) Establish the relation

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

4. (a) How is electromagnetic damping reduced in a ballistic galvanometer? Establish the relation

$$q = \frac{T}{2\pi} \cdot \frac{C}{nAB} \theta_0$$

where θ_0 is the angle through which the suspension fibre is twisted. 1+7=8

(b) Give the significance of Kirchhoff's voltage law. 2

Or

(a) Discuss the discharge of a condenser in a circuit containing inductance only. How will this discharge be affected by the introduction of a resistance? 8

(b) A condenser of capacity 0·25 μF, an inductance of 0·2 henry and resistance of 800 ohm are in series. Show if the circuit is oscillatory. 2

5. *(a)* Find an expression for the average power consumed in a series *L-R* circuit connected to a sinusoidal source of e.m.f. What is power factor? Under what condition the power in the above circuit vanishes? 4+1+1=6

(b) A resistance of 20 ohms is joined in series with an inductance of 1 henry. What capacitance should be put in series with the combination to obtain

the maximum current? What will be the potential differences across the resistance, inductance and capacitance respectively? The current is being supplied by 200 volts, 50 cps a.c. mains. 4

Or

Write short notes on any *two* of the following : 5×2=10

(a) Series electrical resonance

(b) Maxwell's LC bridge

(c) Rotating magnetic field

(d) Continuity equation

6. What is vector magnetic potential? Find the vector potential due to an electric current flowing in a wire at a point outside the wire and hence calculate the magnetic flux density $\vec{B}$. 2+6+2=10

Or

(a) "Divergence of magnetic field is zero whereas divergence of electric field is not zero."

What meaning will you derive about the two fields from the above statement? 3

(b) A rectangular current loop is suspended in a uniform magnetic field. Obtain an expression for the torque on the loop. 7

★★★