

2013

PHYSICS

(Major)

Paper : 3.2

(Current Electricity and Magnetostatics)

Full Marks : 60

Time : 2½ hours

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

1. Answer the following questions : 1×7=7

- (a) Write down the continuity equation that relates the charge density and current density at a point.
- (b) Consider two ballistic galvanometers with ballistic constants 2×10^{-5} coulomb/radian and 2×10^{-4} coulomb/radian. Which of these galvanometers is more sensitive? Justify your answer.
- (c) If an electron initially moving in the x-direction is subjected to a magnetic field in the z-direction, in which direction the electron will be deflected?

- (d) Express 'tesla' in terms of fundamental quantities (M, L, T, I).
- (e) Why no power is dissipated if a voltage of sinusoidal waveform is applied across a purely inductive or capacitive circuit?
- (f) Write down the differential form of Ampere's circuital law for steady currents.
- (g) Distinguish between Joule's heating and Peltier's effect.

2. Answer the following questions : 2×4=8

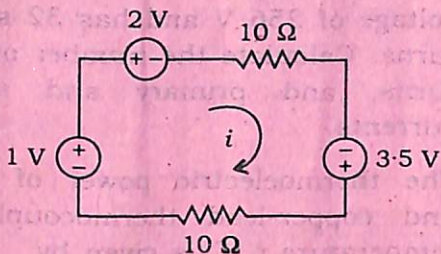
- (a) Establish the relation $V_{\text{rms}} = 0.707 V_0$, where V_{rms} and V_0 are the root mean square and peak values of voltage of sinusoidal waveform respectively.
- (b) Draw the circuit diagram of Anderson's bridge for the measurement of inductance.
- (c) The magnetic vector potential in some region is

$$\vec{A} = x^2 y \hat{i} + y^2 x \hat{j} - 4xyz \hat{k} \text{ Wb/m}$$

Find the magnetic field \vec{B} at the point $(1\text{m}, 3\text{m}, -5\text{m})$.

((3))

(d) From the circuit given below, find the current i :

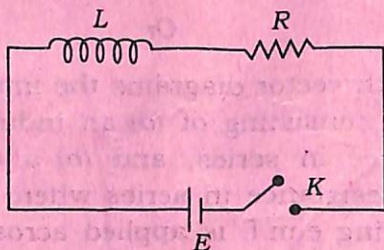


3. Answer any *three* of the following questions :

5×3=15

(a) A charge particle $q = 3.8 \times 10^{-19}$ C is revolving around a circular path of radius $r = 1 \text{ \AA}$ with frequency $f = 10^{15}$ Hz. Calculate the magnetic induction and magnetic moment at the centre of the circular path. (Given, permeability $\mu = 4\pi \times 10^{-7}$ H/m)

(b) The circuit shown below is closed at $t = 0$, where a steady current was flowing prior to the time $t = 0$. Find an expression for transient current flowing through the circuit for $t > 0$:



(c) A single-phase 50 kVA transformer has primary voltage of 6600 V and secondary voltage of 256 V and has 32 secondary turns. Calculate the number of primary turns, and primary and secondary currents.

(d) The thermoelectric power of iron-lead and copper-lead thermocouples at a temperature t °C is given by

$$1734 - 4.8t \text{ } \mu\text{V}/^\circ\text{C} \text{ and}$$

$$136 + 0.95t \text{ } \mu\text{V}/^\circ\text{C}$$

respectively. Find the e.m.f. of a copper-iron thermocouple with junctions at 0 °C and 100 °C.

(e) Obtain an expression for the magnetic field near a straight wire of finite length carrying a steady current.

4. Set up the e.m.f. equation of series *R-L-C* circuit driven by a sinusoidal voltage. Solve the equation to find the instantaneous current. How does the impedance of the circuit behave at resonance? 2+6+2

Or

Find with vector diagrams the impedances of circuits consisting of (a) an inductance and resistance in series, and (b) a capacitance and a resistance in series when a source of alternating e.m.f. is applied across them. 5+5

5. A d.c. e.m.f. is suddenly applied to a circuit consisting of a resistor R and capacitor C in series. Write the e.m.f. equation for the circuit and hence the current at any instant. What is meant by time constant and what is its significance? 2+6+2

Or

Explain the generation of rotating magnetic fields in case of (a) two-phase power supply and (b) three-phase power supply. How is the principle of rotating magnetic fields employed to design induction motor? 4+4+2

6. State and explain Biot-Savart law in magnetostatics. Using the Biot-Savart law, obtain an expression for the magnetic field at a point on the axis of a circular conductor carrying a steady current. 10

Or

Define magnetic scalar potential. Obtain an expression for the magnetic scalar potential and hence magnetic field near a current-carrying loop. 2+6+2
