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3 (Sem-3) PHY M 2

2022

PHYSICS

(Major)

Paper : 3-2

(Current Electricity and Magnetostatics)

Full Marks : 60

Time : Three hours

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

1. Answer the following questions : $1 \times 7 = 7$
 - (a) Write down the Ohm's law that relates the conductivity, current density and electric field.
 - (b) Two inductances of co-efficient of self induction L_1 and L_2 are joined in series. What is the net co-efficient of self induction of the combination ?
 - (c) What do you mean by the time constant in series R-C circuit ?

Contd.

(d) Why no power is dissipated if a voltage of sinusoidal waveform is applied across a purely inductive or capacitive circuit?

(e) What is copper losses in transformer?

(f) Write down the Biot-Savart law.

(g) What is magnetic vector potential?

2. Answer the following questions : $2 \times 4 = 8$

(a) Set up the e.m.f equation of series LCR a.c circuit.

(b) In a certain thermocouple $E = a\theta + b\theta^2$, where $\theta^\circ\text{C}$ is the temperature of the hot junction, the cold junction being at 0°C , $a = 10$ microvolts/ $^\circ\text{C}$ and $b = -\frac{1}{40}$ microvolt/ $^\circ\text{C}$. Find the neutral temperature and the temperature of inversion.

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

(d) Draw the circuit diagram of Anderson's bridge for the measurement of co-efficient of self induction.

3. Answer **any three** of the following questions : $5 \times 3 = 15$

(a) Establish that $\vec{\nabla} \cdot \vec{B} = 0$.

(b) Write a short note on rotating magnetic field.

(c) An alternating voltage of 220 volts and 50 Hz is applied to a circuit which contains an inductance of 0.2 henry and resistance 10 ohms in series. Determine the potential difference across the resistance and the inductance.

(d) The e.m.f of a thermocouple, one junction of which is kept at 0°C , is given by $E = bt + ct^2$. Find the neutral temperature and the Peltier and Thomson co-efficient.

4. (a) Deduce an expression for self inductance of a long solenoid carrying current. 4

(b) An inductor ($L = 20\text{mH}$), a resistor ($R = 100\Omega$) and a cell ($E = 10\text{V}$) are connected in series. Find the time elapsed before the current reaches 99% of the maximum value. [$\ln 100 = 4.6$] 3

- (c) Establish the relation $\pi_2 - \pi_1 = \frac{\pi_1}{T_1}(T_2 - T_1)$

where π_1 and π_2 are Peltier co-efficients.

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Or

Why is Wheatstone bridge not suitable for measurement of very low resistance? Describe with circuit diagram how low resistance can be measured using Kelvin's Double Bridge.

2+8=10

5. (a) 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 this ? 2
- (b) Using the Biot-Savart law, obtain an expression for the magnetic field due to a long straight conductor carrying steady current. 8

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=10

6. (a) Derive an expression to show the growth of electric current in a circuit with resistance and self-inductance.

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- (b) What is meant by resonance in an a.c circuit ? In an a.c circuit containing L , C and R in series, find the condition under which the resonance is obtained.

2+3=5

Or

What is meant by mutual inductance ? Describe with circuit diagram how the mutual inductance can be measured using ballistic galvanometer. 2+8=10