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3 (Sem 3) PHY M2

2015

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 : 1×7=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 ?

[Turn over

- (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 :
5×3=15

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

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(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.
[$\ln 100=4.6$]

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(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.

3

Or

Why Wheatstone bridge is 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.

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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. $2+8=10$