3 SEM TDC PHY M 2

2017

(November)

PHYSICS

(Major)

Course : 302

(Electricity and Magnetism)

Full Marks : 60

Pass Marks : 24/18

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following (symbols have their usual meanings) : 1×6=6

(a) The energy density (u) in a capacitor plate is given by

(i) $\frac{1}{2}\frac{\varepsilon_0}{E^2}$

(ii) $\frac{1}{2}\varepsilon_0^2 E$

(iii) $\frac{1}{2}\varepsilon_0\left(\frac{V}{d}\right)^2$

(iv) $\frac{1}{2}\varepsilon_0 E^2$

(b) For a diamagnetic material, which of the following is correct about relative permittivity (μ_r)?

(i) $\mu_r > 1$

(ii) $\mu_r < 1$

(iii) $\mu_r << -1$

(iv) $\mu_r >> 1$

(c) Which of the following statements is correct?

(i) Faraday's law of electromagnetism is in accordance with the law of conservation of energy.

(ii) Ampere's circuital law is in accordance with the conservation of energy.

(iii) Lenz's law is in accordance with the conservation of energy.

(iv) Lenz's law violates the conservation of energy.

(Continued)

(d) The mean value of a.c. voltage for half cycle is

(i) $\frac{E_0}{\pi}$

(ii) $E_0 \cdot \frac{\pi}{2}$

(iii) $\frac{2E_0}{\pi}$

(iv) $\frac{E_0}{2\pi}$

(e) The power in an a.c. circuit containing resistance, inductance and capacitance is given by

(i) $E_0 \times \frac{I_0}{\sqrt{2}} \cos\theta$

(ii) $E_0 \times I_0 \cos\theta$

(iii) $\frac{E_0}{\sqrt{2}} \times \frac{I_0}{\sqrt{2}} \cos\theta$

(iv) $\frac{E_0}{I_0} \cos\theta$

(f) The power factor of an a.c. circuit containing inductance and resistance in series is

(i) $R\left(\sqrt{R^2 + (L\omega)^2}\right)$

(ii) $\dfrac{R}{\sqrt{R^2 + (L\omega)^2}}$

(iii) $\dfrac{R}{\sqrt{\dfrac{1}{L^2\omega^2} + R^2}}$

(iv) $\dfrac{\sqrt{R^2 + (L\omega)^2}}{R}$

2. (a) Derive an expression for the energy stored in unit volume of an electric field. 4

Or

Give physical significance of divergence and curl of a vector function. 4

(b) Find the potential inside and outside a spherical shell of radius R which carries a uniform surface charge. Set the reference point at infinity. 3+2=5

(c) Deduce an expression for the capacitance of a spherical capacitor when the inner sphere is grounded. 3

(d) Establish the relation between di-electric constant (k) and electric susceptibility (χ_s). 3

(e) What do you mean by molecular polarizability? Deduce an expression for the electric field on a molecule within the dielectric. 2+4=6

3. (a) Distinguish between deadbeat and ballistic galvanometers. 3

(b) What is the principle of a moving-coil galvanometer? Can it be used for a.c. measurement? What are its advantages? 2+1+1=4

(c) Find the value of the inductance which if connected in series with a capacitor of 0·5 μF, a resistance of 10 Ω and an a.c. source of frequency 50 Hz, the power factor in the circuit is unity. 3

Or

Describe a method for the measurement of thermo-e.m.f. 3

4. (a) Derive an expression for the flux density at a point inside a long solenoid. Hence prove that the flux density at the end of an infinitely long solenoid is double as much as that at its middle. 3+2=5

(b) Discuss in an elementary manner the atomic origin of diamagnetic, paramagnetic and ferromagnetic materials. 3

(c) Establish the relation

$$B = \mu_0 (H + M)$$ 3

Or

How do you use the hysteresis curves to select materials for construction of *(i)* permanent magnet and *(ii)* electro-magnet? 3

5. *(a)* Give the theory of series resonant circuit and state its properties. What is meant by sharpness of resonance? How does it depend on the sharpness of the circuit? 3+1+1=5

(b) Obtain the expression for power consumed in an a.c. circuit. 4

Or

The resistance of a certain d.c. motor is 0·25 ohm. When running without load on 100 volts supply, it takes 1·5 amp, whilst on full load, the current rises to 35 amp. Find the back e.m.f. in each case and the electrical efficiency in the second. 4

(c) Describe Anderson's bridge method for determining the self-inductance of a coil. 3

Or

Show that in case of a.c., the potential drop across an inductor leads the current by 90° and that across a capacitor lags the current by 90°. 3

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