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3 SEM TDC PHY M 2

2019

(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) If the amounts of elective flux entering and leaving an enclosed surface are ϕ_1 and ϕ_2 respectively, the electric charge inside the surface will be

(i) $\frac{\phi_1 + \phi_2}{\varepsilon_0}$

(ii) $\frac{\phi_2 - \phi_1}{\varepsilon_0}$

(iii) $(\phi_1 + \phi_2)\varepsilon_0$

(iv) $(\phi_2 - \phi_1)\varepsilon_0$

(b) The susceptibility of an ideal diamagnetic substance is

(i) ∞

(ii) 0

(iii) -1

(iv) $+1$

(c) The curl of the gradient of a scalar function is

(i) zero

(ii) a scalar

(iii) a vector

(iv) undefined

(d) The impedance of an *L*-C-*R* circuit will be minimum, if

(i) $X_L = 0$

(ii) $X_L \neq X_C = 0$

(iii) $X_L = X_C$

(iv) None of the above

(e) In a parallel-plate condenser, the distance between the plates is d and its potential difference is V. The energy stored per unit volume of the capacitor is

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

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

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

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

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

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

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

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

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

2. *(a)* What do you mean by surface integral of a vector function? 1

(b) State Stokes' theorem in vector algebra. 1

(c) Show that

$$\vec{\nabla}\cdot(\phi\vec{A}) = (\vec{\nabla}\phi)\cdot\vec{A} + \phi(\vec{\nabla}\cdot\vec{A})$$ 3

3. *(a)* By using Gauss theorem in electrostatics, find the expressions for the field strength due to an infinite uniform plane sheet of charge. 3

(b) Define the polarizability of a dielectric material. Derive the Clausius-Mossotti equation connecting polarizability with the dielectric constant of the material. 1+4=5

(c) Deduce an expression for the capacity of two coaxial cylinders separated by a layer of dielectric constant k. 3

4. *(a)* By using Kirchhoff's laws, establish the balanced condition of the Wheatstone bridge. 2

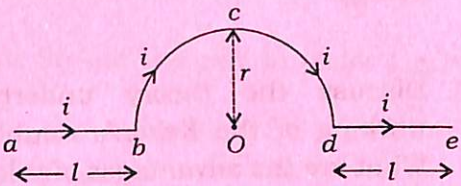
(b) Discuss the theory underlying the working of the Kelvin's double bridge. What are the advantages of this bridge? 2+1=3

(c) The e.m.f. of a thermocouple of which one junction is at 0 °C and the other at 50 °C is 25 microvolts. The neutral temperature is 100 °C. Find the e.m.f. when the junctions are at 0 °C and 200 °C. 3

(d) What is the 'time constant' of the CR-circuit? Draw the charge decay curve and mark the time constant for such circuit. 2

5. *(a)* Find the magnetic field at any axial point due to a current-carrying solenoid. 4

(b) A long wire having a semi-circular loop of radius r carries a current i as shown in the figure below :



Find the magnetic induction at the centre O due to entire wire. 3

(c) What are diamagnetic, paramagnetic and ferromagnetic substances? Give examples of each of them. 4

6. (a) What do you mean by self-inductance and mutual inductance? Discuss a method for determining self-inductance of a coil.

2+4=6

(b) What do you mean by average e.m.f. and virtual e.m.f.? Establish a relation between them. 2+2=4

(c) An alternating voltage of 100 volts is impressed on a series circuit having an inductance of 1 mH, a capacitance of 0·1 μF and a resistor of 50 ohms. Find—

(i) the resonance frequency;

(ii) the potential difference across the inductance;

(iii) the potential difference across inductor-capacitor combination at resonance. 2+2+3=7

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