2 0 1 5

(November)

PHYSICS

(Major)

Course : 302

(Electricity and Magnetism)

Full Marks : 60

Pass Marks : 24 (Backlog)/18 (2014 onwards)

Time : 3 hours

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

1. Choose the correct option from the following :   1×6=6

   (a) $\nabla \cdot \vec{D} = \rho$ is based on

   (i) Ampere's law

   (ii) Faraday's law

   (iii) Ohm's law

   (iv) Gauss' law

(b) The unit of polarisation $\vec{P}$ is

(i) same as that of $\vec{E}$

(ii) same as that of $\vec{D}$

(iii) same as that of $\vec{E}$/coulomb

(iv) same as that of charge

(c) Closed-circuit technique is based on

(i) Thevenin's theorem

(ii) Norton theorem

(iii) Kirchhoff's current law

(iv) Kirchhoff's voltage law

(d) Which one is correct?

(i) $\vec{B} = \vec{H} + \vec{M}$

(ii) $\vec{B} = \mu_0(\vec{H} + \vec{M})$

(iii) $\vec{B} = \vec{H} + \mu_0\vec{M}$

(iv) None of the above

(e) If an L-C-R circuit is to be oscillatory, then it should satisfy

(i) $\dfrac{1}{LC} < \dfrac{R^2}{4L^2}$

(ii) $\dfrac{1}{4L^2} = \dfrac{R^2}{4L^2}$

(iii) $\dfrac{1}{LC} > \dfrac{R^2}{4L^2}$

(iv) $\dfrac{L}{C} = \dfrac{R^2}{4}$

(f) The mutual inductance between two coils is 5 henry. If in $\dfrac{1}{1000}$ second 3 ampere current of the primary coil is completely stopped, then the induced e.m.f. in the secondary coil is

(i) 15000 volt

(ii) 1500 volt

(iii) 150 volt

(iv) None of the above

2. (a) What are polar and non-polar molecules? Give examples. 1+1+½+½=3

(b) The e.m.f. equation of a copper-nickel couple in microvolt is $E = 16 \cdot 34t - 0 \cdot 021t^2$, t is in °C. Calculate the thermoelectric power at 100 °C.

3

(c) A magnetic field of 20 e.m.u. produces a flux of 2400 e.m.u. in a bar of cross-section 0·2 sq. cm. Calculate the susceptibility and permeability of iron. 3

(d) What is the difference between a step-up and a step-down transformer? What is the transformer ratio? Can a transformer step-up or step-down a d.c. voltage? 1+1+1=3

3. (a) State and prove Gauss' divergence theorem. 2+7=9

(b) Define capacitance of a conductor. What is an electrical capacitor? Deduce an expression for the capacitance of a parallel-plate air capacitor. How will it be modified when the gap between the plates is filled with dielectric? 1+1+3+3=8

4. State and prove Kirchhoff's laws of distribution of currents in an electrical network. 1+1+2+2=6

Or

Prove that $dE = d\pi + (\sigma_A - \sigma_B)\, dT$, the symbols having usual meaning. 6

5. Define permeability and magnetic susceptibility. Show that $\mu = \mu_0(1 + \chi_m)$.

$$2+2+3=7$$

Or

What is a solenoid? Obtain an expression for the field on the axis of a solenoid. $\quad 1+6=7$

6. (a) What is self-inductance? Show that the energy required to build up a current I in a circuit of self-inductance L is $\frac{1}{2}LI^2$.

$$1+5=6$$

(b) Define pure inductance. Show that the current in an inductive circuit lags behind the voltage by 90°. Plot the current, self-induced e.m.f. and voltage curve and construct the vector diagram for an inductive circuit. $\quad 1+3+1+1=6$

Or

Deduce equation for current in a capacitive circuit. Plot the current and voltage curves for the capacitive circuit.

$$4+2=6$$

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