2019

PHYSICS — HONOURS

Paper : CC–3

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question no.* 1** and ***any four*** from the rest.

1. Answer ***any five*** questions : 2×5

(a) Check whether the following represent electrostatic fields or not :

$$\vec{E}_1 = \left(4y\hat{i} - 2x\hat{j} - \hat{k}\right); \vec{E}_2 = \left(4xy - z^3\right)\hat{i} + 2x^2\hat{j} - 3xz^2\hat{k}.$$

(b) Verify that for a charged spherical conductor of radius a, $\epsilon_0 \int E^2 dv = \frac{Q^2}{4\pi\epsilon_0 a}$.

(c) State and explain Gauss' law in dielectric medium.

(d) A charge of $4C$ is moving with a velocity $\vec{v} = \left(2\hat{i} + 3\hat{k}\right)$ in a magnetic field $\vec{B} = \left(2\hat{j} + 5\hat{k}\right) Wb/m^2$. Find the force acting on the charge.

(e) A 1·5m long solenoid of 0·4cm diameter possesses 10 turns per cm length. A current of 5A flows through it. Find the magnetic field at the axis inside the solenoid.

(f) A sample of gold having magnetic susceptibility $-3{\cdot}6 \times 10^{-5}$ is placed in a magnetising field of strength 60×10^3 A turn/m. Find the magnetic induction within the sample.

(g) If the wave form of a current has form factor 1·2 and peak factor 1·7, find the average and *r.m.s* value of the current if maximum current is 100A.

2. (a) Show that electric field is always perpendicular to a equipotential surface.

(b) A point charge 'q' is placed symmetrically at a distance 'd' from two perpendicularly placed grounded conducting infinite plates. Calculate the net force F on the charge 'q'.

(c) A point charge q is placed at a distance r_0 from the centre of a grounded spherical conductor of radius $a(a > r_0)$. Find by method of electrical image the electric field at an external point and total charge induced on the sphere. 2+2+(4+2)

3. (a) Define an electric dipole. Calculate the potential and field due to an electric dipole of dipole moment $4{\cdot}5 \times 10^{-10}$ coulomb meter at a point at a distance 1 meter from it on its axis.

   (b) The distance between the plates of a parallel plate condenser is d. A dielectric slab of thickness x is introduced in the air gap. Show that the capacity of the condenser will be doubled if the dielectric constant of the slab is $k = \dfrac{2x}{2x-d}$. (1+5)+4

4. (a) What is Lorentz force? A long straight conductor carries a current I. Determine the force per unit length of the conductor when it is placed in a uniform magnetic field.

   (b) State Faraday's Law of electromagnetic induction and express it in differential form.

   (c) Explain how Maxwell generalized Ampere's circuital law. (2+2)+(2+2)+2

5. (a) Draw magnetisation curves for soft iron and steel on the same graph as each is taken through a complete cycle of magnetic field.

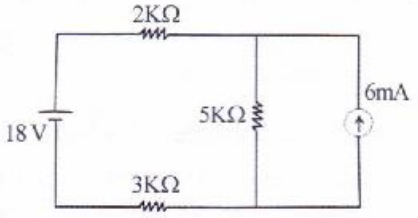
   (b) With reference to the above curves, compare the properties of the two samples with respect to residual magnetism, coercive force and hysteresis loss.

   (c) A specimen of iron of density 7700 Kg/m^3 and specific heat 462 $JKg^{-1}K^{-1}$ is magnetized by an ac field of frequency 50 Hz. Assuming no loss of heat, calculate rise in temperature of the specimen per minute. Given that the area enclosed by the B-H loop of the specimen is equivalent to 5000 $Jm^{-3}cycle^{-1}$.

   (d) State Kirchhoff's Voltage Law. Show that it is consistent with the principle of conservation of energy. 2+3+3+2

6. (a) What is Maximum Power Transfer Theorem? Using this theorem, show that Power Transfer Efficiency cannot exceed 50%.

   (b) State Superposition Theorem for a network of electrical circuit. Using this theorem, find the potential drop across the 5KΩ resistor.



(2+3)+(2+3)

7. (a) Prove that for parallel LCR circuit at resonance the impedance of the circuit is maximum.

   (b) From current response curve for a series LCR circuit, show how Q-factor of the circuit quantifies the sharpness of resonance.

   (c) A 230V, 50Hz voltage is applied to a coil L = 5H and $R = 2\Omega$ in series with a capacitance C. What value must C have in order that the voltage across the coil be 400 V? 4+2+4