2020

ELECTRONICS — HONOURS

Paper : CC-7

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, taking ***two*** from ***each Unit***.

1. Answer ***any ten*** questions from the following. Indicate the correct alternative(s). [*More than one option may be correct.*] 1×10

(a) A vector equally inclined to all three axes is

(i) $\hat{i}+\hat{j}+\hat{k}$ (ii) $\hat{i}-\hat{j}+\hat{k}$

(iii) $\hat{i}-\hat{j}-\hat{k}$ (iv) $-\hat{i}+\hat{j}-\hat{k}$.

(b) A vector has initial point (2, 1) and terminal point (– 5, 7). The x and y components of the vector are respectively

(i) $-3\hat{i}$ and $8\hat{j}$ (ii) $-7\hat{i}$ and $-6\hat{j}$

(iii) $7\hat{i}$ and $6\hat{j}$ (iv) $-7\hat{i}$ and $6\hat{j}$.

(c) The electric field $\vec{E}$ and the electric potential φ are related by

(i) $\vec{E}=-\vec{\nabla}\varphi$ (ii) $\vec{E}=\vec{\nabla}\varphi$

(iii) $\vec{E}=-\nabla^2\varphi$ (iv) $\varphi=\vec{\nabla}\cdot\vec{E}$.

(d) The energy density in an electrostatic field is

(i) $E^2/(2\epsilon)$ (ii) $\epsilon E^2/2$

(iii) $2\epsilon/E^2$ (iv) $2\epsilon E^2$.

(e) The differential form of Faraday's law of electromagnetic induction is

(i) $\vec{E}=-\frac{\delta B}{\delta t}$ (ii) $\vec{\nabla}\times\vec{B}=-\frac{\partial\vec{E}}{\partial t}$

(iii) $\vec{\nabla}\times\vec{E}=-\frac{\partial\vec{B}}{\partial t}$ (iv) $\vec{\nabla}\times\vec{E}=0$.

(f) The energy density in a magnetic field is

(i) $H^2/(2\mu)$ (ii) H^2/μ

(iii) $0.5\,\mu H^2$ (iv) $\vec{B}.\vec{H}$.

(g) The magnitude of the e.m.f. induced in a coil equals :

(i) $\frac{di}{dt}$ (ii) $\frac{d\vec{B}}{dt}$

(iii) $L\frac{d\varphi_B}{dt}$ (iv) $N\frac{d\varphi_B}{dt}$.

(Symbols have their usual meanings.)

(h) Polarization of a dielectric material occurs due to

(i) electrons (ii) bound charges

(iii) free charge (iv) both electrons and bound charges.

(i) The Pointing vector is given by

(i) $\vec{E}\times\vec{H}$ (ii) $0.5\vec{E}\times\vec{H}$

(iii) $\vec{\nabla}\times\left(\vec{E}\times\vec{H}\right)$ (iv) $\vec{H}\times\vec{E}$.

(j) For a plane monochromatic wave travelling in a dielectric medium, the phase difference between $\vec{E}$ and $\vec{H}$ is

(i) 0° (ii) 90°

(iii) 180° (iv) 60°.

(k) The $\vec{E}$ -field of an electromagnetic wave incident normally on the surface of a good conductor suffers, due to reflection, a phase shift of

(i) 0° (ii) 45°

(iii) 90° (iv) 180°

(l) The net force on an electric dipole placed in a uniform electric field

(i) depends on its dipole moment (ii) depends on the intensity of the electric field

(iii) depends on its orientation (iv) is zero.

Unit - I

2. (a) What is meant by curl of a vector? Prove that curl of grad $\Phi = 0$.

(b) If $\vec{r}$ is a position vector, prove that $\vec{\nabla}\left(\frac{1}{r}\right) = -\frac{\vec{r}}{r^3}$.

(c) State Stoke's theorem. (2+3)+3+2

3. (a) State Gauss's law for dielectrics. Obtain its differential form.

(b) Using Gauss's law derive an expression for the electric field at a point inside a uniformly charged sphere. Hence prove that the electric field inside a charged hollow metallic sphere is zero.

(c) $\vec{E}$ is the electric field at a point. Prove that $\vec{\nabla} \times \vec{E} = 0$. (1+3)+(3+1)+2

4. (a) Write down Laplace's equation in Electrostatics. Solve the equation to find the expression for the potential at a distance 'r' from the axis of an infinitely long conducting cylinder of radius 'r_0' having a surface density of charge σ. Assume the potential of the cylinder is zero.

(b) State the boundary conditions for $\vec{B}$ and $\vec{H}$, where the symbols have their usual meanings.

(c) What is meant by magnetic circuit? Consider a long air-core coil of length 'l' having 'N' number of turns and carrying a current 'I'. Find the magnetic intensity. 4+2+(2+2)

5. (a) What is meant by an electrical image?

(b) Show that the magnetic energy stored in an inductor of self-inductance 'L' carrying a current 'I' is $0.5\ LI^2$. Hence define self-inductance.

(c) Derive an expression for the self-inductance of an infinitely long solenoid. 2+(4+1)+3

Unit - II

6. (a) Write Maxwell's electromagnetic equations. Which of these equations is related to the fact that an isolated magnetic pole does not exist? Show how Maxwell's equations in free space imply local conservation of charge (continuity equation).

(b) What is the importance of displacement current? (4+1+3)+2

7. (a) Starting from Pointing vector, show that the energy flow of an electromagnetic wave is along the direction of propagation of the wave and is damped off exponentially.

(b) When is a wave said to be polarized? What is meant by plane of polarization? What are polarization vectors? 5+(2+1+2)

8. (a) What are normal dispersion and anomalous dispersion? Explain briefly. 5+5

(b) Give a theoretical account of anomalous dispersion from electromagnetic theory. 4+6

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