CBCS SCHEME

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17EC36

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Engineering Electromagnetic

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. State Coulomb's law of force between two point charges in vector form. Also derive an expression for the total force due to 'n' number of point charges. **(08 Marks)**

b. Obtain an expression for electric field intensity at a given point due to 'n' number of point charges. **(04 Marks)**

c. Four point charges each of 10μc are placed in free space at the points (1, 0, 0), (–1, 0,0), (0, 1, 0) and (0, –1, 0)m, respectively. Determine the force on a point charge of 30μc located at a point (0, 0, 1)m. **(08 Marks)**

OR

2 a. Derive an expression for electric field intensity at a given point due to infinite line charge. **(08 Marks)**

b. Define electric flux density. Derive the equation for flux density due to point and line charge. **(05 Marks)**

c. A line charge density $\rho_L = 24nc/m$ is located in free space on the line y = 1 and z = 2m.

i) Find $\vec{E}$ at the point P(6, –l, 3)

ii)What point charge Q_A should be located at A(–3, 4, 1) to make y component of total $\vec{E}$ zero at point P. **(07 Marks)**

Module-2

3 a. i) State and prove Gauss law. Give its mathematical representation.

ii) State and prove divergence theorem. **(08 Marks)**

b. The flux density within the cylindrical volume bounded by r = 5m, z = 0 and z = 2m is given by $\bar{D} = 30e^{-r}\vec{a}_r - 2z\hat{a}_z\ c/m^2$. What is the total outward flux crossing the surface of the cylinder? **(12 Marks)**

OR

4 a. What is potential? Also derive the expression for potential due to a point charge and given the concept of absolute potential. **(08 Marks)**

b. Find the work done in moving a point charge of 5μc in the electric field defined by $\vec{E} = 4x\hat{a}_x - 3y\hat{a}_y\ V/m$.

i) From (3, 0, 0) to (0, 0, 0) and from (0, 0, 0) to (0, 3, 0)

ii) From (3, 0, 0) to (0, 3, 0) along the straight line path joining the two points. **(12 Marks)**

Module-3

5 a. Derive Laplace's and Poisson's equations. **(06 Marks)**

b. State and prove uniqueness theorem. **(06 Marks)**

c. In a free space, $\rho_v = \frac{200\varepsilon_0}{r^{2.4}}$

i) Use Poisson's equation, to find 'V' as a function of r, if it is assumed that r^2E_r is$\rightarrow 0$ as $r \rightarrow 0$ and $V \rightarrow 0$ as $r \rightarrow \infty$. Use spherical co-ordinate system.

ii) Find potential 'V' as a function of 'r' using Gauss's law and line integral. **(08 Marks)**

OR

6 a. State and prove Biot-Savart law in its integral form. **(08 Marks)**

b. Derive the equations for scalar and vector magnetic potentials. **(04 Marks)**

c. Given $\vec{H} = 20r^2\,\hat{a}_\phi$ A/m.

i) Determine the current density $\bar{J}$

ii) Also determine the total current that crosses the surface $r = 1m$, $0 < \phi < 2\pi$ and $z = 0$ (in cylindrical co-ordinates). **(08 Marks)**

Module-4

7 a. State and explain the Lorentz force equation. **(06 Marks)**

b. Derive an equation for the force between the two differential current elements. **(06 Marks)**

c. A point charge of $Q = -1.2C$ has velocity $\vec{V} = (5\hat{a}_x + 2\hat{a}_y - 3\hat{a}_z)$ m/s. Find the magnitude of the force exerted on the charge if,

i) $\vec{E} = -18\hat{a}_x + 5\hat{a}_y - 10\hat{a}_z$ V/m

ii) $\vec{B} = -4\hat{a}_x + 4\hat{a}_y + 3\hat{a}_z)$T

iii) Both are present simultaneously. **(08 Marks)**

OR

8 a. Derive the tangential and normal magnetic boundary conditions. Also derive the equation for component of $\vec{B}$ at boundary. **(10 Marks)**

b. In region 1, as shown in Fig.Q8(b), $\vec{B}_1 = 1.2\hat{a}_x + 0.8\hat{a}_y + 0.4\hat{a}_z$ Tesla. Determine $\vec{B}_2$ and $\vec{H}_2$ in other medium and also calculate the angles made by the fields with the normal.

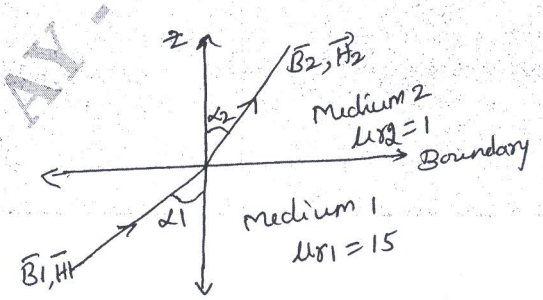

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. State and explain Faraday's law and Lenz's law. Also explain the physical significance of displacement current with proper derivation. **(10 Marks)**

b. List the Maxwell's equations in point and integral form for static fields and time varying fields. Mention their significance. **(10 Marks)**

OR

10 a. Derive the general wave equations using the Maxwell's equations. **(10 Marks)**

b. State and explain Poynting theorem. A 9375MHz uniform plane wave is propagating in polystyrene. If the amplitude of the electric field intensity is 20V/m and the material is assumed to be lossless, find :

i) Attenuation constant
ii) Phase constant
iii) Wavelength in polystyrene
iv) Velocity of propagation
v) Intrinsic impedance
vi) Propagation constant
vii) Amplitude of the magnetic field intensity.

For polysterem, $\mu_r = 1$, $\varepsilon_r = 2.56$. **(10 Marks)**

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