B.E. (Electrical Engineering (Electronics & Power)) Fourth Semester (C.B.S.)

Elements of Electromagnetics Paper - II

P. Pages : 3 **TKN/KS/16/7367**

Time : Three Hours * 0 7 7 3 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.

1. a) i) Give the Cartesian co-ordinates of point C (4.4, -115°, 2). **6**

ii) Give cylindrical co-ordinates of point D (-3.1, 2.6, -3).

iii) Specify distance from C to D.

b) Given points A (2, 5, -1), B(3, -2, 4) & C (-2, 3, 1) find **7**

i) $\overline{R}_{AB}.\overline{R}_{AC}$

ii) Angle between $\overline{R}_{AB}$ and $\overline{R}_{AC}$.

iii) Length of projection of $\overline{R}_{AB}$ on $\overline{R}_{AC}$.

iv) Vector projection of $\overline{R}_{AB}$ on $\overline{R}_{AC}$.

OR

2. a) A pair of diametrically opposite corners of the volume is

$P_1(r = 5,\ \theta = 20^o,\ \phi = 0.1\pi)$

$P_2(r = 12,\ \theta = 80,\ \phi = 0.4\pi)$

i) Find length of straight line connecting diametrically opposite corners of the volume. **2**

ii) Find volume enclosed by the surfaces. **3**

iii) Find area of the enclosing surfaces. **3**

b) Give the Cartesian components of vector. **5**

$\overline{H} = 20\hat{a}_\rho - 10\hat{a}_\phi + 3\hat{a}_Z$ at P (5, 2, -1).

3. a) Three point charges are located in free space as follows. **6**

$Q_1 = -6\ \mu c$ at $P_1(1,0,0)$
$Q_2 = 10\ \mu c$ at $P_2(2,0,0)$
$Q_3 = 4\ \mu c$ at $P_3(4,0,0)$

Which charge has greatest magnitude of force on it? What is the magnitude of that force.

b) State Coulomb's law. Derive an expression for electric field intensity for line charge. **7**

OR

4. a) A uniform line charge of density $100\,nc/m$ lies between z = 3 & z = 7 on z – axis. No other charge is present Find $\overline{E}$ at origin. **6**

b) Find the total charge inside the volume for each of the following. **7**

i) $\rho_v = 10z^2 e^{-0.1x} \sin \pi y$
$-1 \le x \le 2,\ 0 \le y \le 1,\ 3 \le z \le 3.6$

ii) $\rho_v = 4xyz^2,\ 0 \le \rho \le 2,\ 0 \le \phi \le \pi/2,\ 0 \le z \le 3$

iii) $\rho_v = \dfrac{1}{x^3 y^3 z^3},\ 0.1 \le |x|; |y|, |z| \le 0.2$

5. a) State divergence theorem. Give physical significance of divergence. **5**

b) Find the potential & volume charge density at P (0.5, 1.5, 1) in free space given the potential field. **9**

i) $V = 2x^2 - y^2 - z^2\ V$

ii) $V = 2(2r^2 - 7)\cos\theta \cos\phi\ V$

iii) $V = 6\rho\phi z\ V$

OR

6. a) Define electric potential. Show that $\overline{E} = -\nabla V$. **7**

b) Given the flux density **7**

$$\overline{D} = \frac{2\cos\theta}{r^3}\hat{a}_r + \frac{\sin\theta}{r^3}\hat{a}_\theta\ \ c/m^2$$

Evaluate both sides of divergence theorem for the region defined by

$1 < r < 2,\ 0 < \theta < \pi/2,\ 0 < \phi < \pi/2$

7. a) Derive Laplace's equation. Express Laplace's equation in cylindrical and spherical co-ordinate. **7**

b) Find relative permittivity of dielectric material used in parallel plate capacitor if **6**

i) $C = 40\,nF,\ d = 0.1mm,\ S = 0.15\,m^2$

ii) $d = 0.2\,mm,\ E = 500\,kv/m\ \&\ \rho_s = 10\,\mu c/m^2$

iii) $D = 50\,\mu c/m^2$ & energy density is $20\,J/m^3$.

OR

8. a) Derive the boundary conditions for the boundary between two dielectric materials. **7**

b) The region z < 0 contains a perfect dielectric for which $\in_{R_1} = 2.5$ while the region $z > 0$ **6**

is characterized by $\in_{R_2} = 4$. Let $\overline{E}_1 = -30\hat{a}_x + 50\hat{a}_y + 70\hat{a}_z\ V/m$.

Find $\overline{E}_{N_1}, \overline{E}_{t_1}, \overline{E}_1, \overline{D}_{N_2}, \overline{D}_{t_2}, \overline{D}_2, P_2$ & Angle θ_2 between E_2 & a normal to the surface.

9. a) State & Explain Ampere's circuital law. **6**

b) **8**

Given $\overline{H} = \left[\frac{10r^2}{\sin\theta}\right]\hat{a}_\theta + 180\,r\cos\theta\,\hat{a}_\phi\ \ A|m$

in free space. Find the current in $\hat{a}_\theta$ direction through the conical surface $\theta = 30^\circ.\ 0 \le \phi \le 2\pi,\ 0 \le r \le 2$ by using any one side of Stoke's theorem.

OR

10. a) State & Explain. **8**

i) Biot – Savart's Law.

ii) Stoke's theorem.

b) Derive the expression for inductance per unit length of co-axial cable. **6**

11. Explain the following terms :

i) Depth of Penetration. **4**

ii) Poynting Vector. **5**

iii) Skin Effect. **4**

OR

12 a) State Maxwell's equation in point form for time varying fields. **4**

b) A 150 MHz uniform plane wave in free space is travelling in the $\hat{a}_x$ direction. The electric field intensity has a maximum amplitude of $200\hat{a}_y + 400\hat{a}_z\ V/m$ **9**

at P (10, 30, -40) at time t = 0 Find.

i) ω ii) β

iii) λ iv) ν

v) η vi) $\overline{E}(x, y, z, t)$

vii) Use one or more Maxwell's equation to find $\overline{H}(x, y, z, t)$.

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