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

Elements of Electromagnetics

P. Pages : 3 **NRT/KS/19/3364**

Time : Three Hours *0638* 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.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Use of non programmable calculator is permitted.

1. a) The three vertices of a triangle are located at M (-1, 2, 1), N (3, -3, 0) and P (-2, -3, -4). Find : **8**

i) $\bar{R}_{MN} \times \bar{R}_{MP}$

ii) $\bar{R}_{MN} \cdot \bar{R}_{MP}$

iii) The angle θ_{NMP} at vertex M.

iv) The vector projection of $\bar{R}_{MN}$ on $\bar{R}_{MP}$

v) A unit vector perpendicular to the plane in which the triangle is located.

b) Find the unit vector in spherical co-ordinate system at M (5, 20º, 100º) directed towards N (4, 70º, 50º). **6**

OR

2. a) Obtain the spherical co-ordinates of **6**

i) $10\hat{a}_y$ at point P (-3, 2, 4)

ii) $10\,\hat{a}_z$ at point P (4, 110º, 120º)

b) An Electric field intensity is given by **8**

$$\bar{E} = \frac{50\cos\theta}{r^3}\hat{a}_r + \frac{\sin\theta}{r^2}\hat{a}_\theta$$

at point whose spherical co-ordinates are P (2, 60º, 30º)
Find :

i) The magnitude of $\bar{E}$.

ii) Transform into Cartesian co-ordinate and evaluate unit vector of $\bar{E}$.

3. a) A point charge $Q_A = 1\,\mu C$ is at A (0, 0, 1) and $Q_B = 1\,C\mu$ is at B (0, 0, -1). Find E_r, E_θ, E_ϕ at point (1, 2, 3). **6**

b) State and explain Couloumb's law. Derive an expression for electric field intensity of an infinite uniform surface charge having ρ_s c / m^2. **7**

OR

4. a) Two infinite sheet of uniform charge density $\rho_s = \frac{10^{-9}}{6\pi} c/m^2$ are located at z = -5m, y = -5m. Determine the uniform line charge density ρ_L necessary to produce the same value of $\bar{E}$ at (4, 2, 2) as produced by the two surface charges. If the line charge is located at z = 0, y = 0. **6**

b) Volume charge density $\rho_v = 40xyz\ c/m^3$ exists for x, y, z positive. Find total charge in the region **7**

a) $0 \le x; y; z \le 2$

b) $x = 0, y = 0, 0 \le 2x + 3y \le 10; 0 \le z \le 2$

5. a) Electric field is, $\bar{E} = (6y^2z\,\hat{a}_x + 12xyz\,\hat{a}_y + 6xy^2\hat{a}_z)$. An incremental path is, $\bar{\Delta L} = -3\hat{a}_x + 5\hat{a}_y - 2\hat{a}_z\ \mu m$. Find workdone in moving $2\mu C$ charge along this path at $P_A(0, 2, 5)$ & $P_B(1,1,1)$. **6**

b) Given the flux density **7**

$$\bar{D} = 6\rho\sin\left(\frac{1}{2}\phi\right)\hat{a}_\rho + 1.5\rho\cos\left(\frac{\phi}{2}\right)\hat{a}_\phi\ c/m^2$$

Evaluate both sides of divergence theorem for the region bounded by $\rho = 0, \rho = 2$, $\phi = 0, \phi = \pi, z = 0, z = 5$.

OR

6. a) The potential field is given in the free space by **6**

$V = 2x^2y + 20z - 4\ln(x^2 + y^2)$

find :

i) Electric field at P (6, -2.5, 3)

ii) Volume charge density at P (6, -2.5, 3) in free space.

b) For point P (4, 60°, 1) in cylindrical co-ordinates and the potential field **7**

$V = 10(\rho - 1)z^2\cos\phi$ volts in free space find at P.

i) V ii) D

iii) $\frac{dV}{\partial N}$ iv) $\hat{a}_N$

v) ρ_v

7. a) The region x > 0 contains a dielectric material for which $\in_{r_1} = 3$ & in the region **6**

$x < 0\ \in_{r_2} = 5$.

If $E_2 = 20\hat{a}_x + 30\hat{a}_y - 40\hat{a}_z\ (V/m)$

find :

i) $\bar{D}_2$ ii) $\bar{D}_1$ iii) $\vec{P}_1$

b) Derive an expression for the capacitance of a parallel plate capacitor having two dielectric medium one over the other. **7**

OR

8. a) Explain properties of perfect conductor and derive the conditions at the boundary of perfect conductor. **7**

b) Derive Laplace's Equation. Express Laplace's equation for Cartesian, Cylindrical and spherical co-ordinates. **6**

9. a) State and explain Bio – Savart's law. Write only curl equation in different co-ordinate system. **6**

b) A current of 10A is flowing in $\hat{a}_z$ direction in a filament extending along z axis. Find $\overline{H}$ in Cartesian co-ordinates at P (3, 4, 5). If the filament lies between z = 0 to z = 10. **7**

OR

10. a) Find $\overline{\nabla} \times \overline{H}$ if $\overline{H}$ equals : **6**

i) $y^2 z\, \hat{a}_x + 2(x+1)yz\, \hat{a}_y - (x+1)\, z^2\, \hat{a}_z$

ii) $2r \cos\theta\, \hat{a}_r - 3r \sin\theta\, \hat{a}_\theta$

b) A toroidal core is composed of a material with $\mu_r = 25$. The boundary surfaces are z = 0, z = 0.025, $\rho' = 0.025$ and $\rho = 0.04$m. The wire is wound symmetrically with 12000 turns of wire such that $\overline{H}$ is in the $\hat{a}_\phi$ direction. Find the inductance. **7**

11. a) Write Maxwell's equations in differential form and integral form for time varying fields. **6**

b) A 9375 MHz uniform plane wave is propagating in polystyrene. If the amplitude of the electric field intensity is 20 V/m and the material is assumed to be lossless. **8**
Find :

i) The phase constant.
ii) The wavelength
iii) Velocity of propagation
iv) The intrinsic impedance.
v) The propagation constant.

OR

12. Write short notes on :

a) Attenuation constant and phase constant. **5**

b) Poynting Vector. **5**

c) Characteristics impedance. **4**

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