B.E. Electronics Engineering / Electronics & Telecommunication / Communication Engineering Fourth Semester

EN / ET 403 - Electromagnetic Fields

P. Pages : 2 **GUG/W/18/1556**

Time : Three Hours Max. Marks : 80

Notes :
1. All questions carry as indicated marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.

1. a) Given two vectors **8**

$\bar{r}_A = -\hat{a}_x - 3\hat{a}_y - 4\hat{a}_z$

$\bar{r}_B = 2\hat{a}_x + 2\hat{a}_y + 2\hat{a}_z$

and point C having Co-ordinates C(1, 3, 4), find

i) $\bar{R}_{AB}$ ii) $|\bar{r}_A|$

iii) $\bar{a}_A$ iv) $\bar{a}_{AB}$

v) A unit vector directed from point C to point A.

b) For a vector field $\bar{A} = 30^{-\rho}\,\hat{a}_\rho - 2z\hat{a}_z$. Determine if the field is solenoidal or non-solenoidal at P(2, 30º, 5). **8**

OR

2. a) Prove that **8**

i) $\nabla(ab) = a\bar{\nabla}b + b\bar{\nabla}a$ ii) $\nabla\cdot(a\bar{B}) = \bar{B}\cdot\bar{\nabla}a + a(\bar{\nabla}\cdot B)$

b) Explain what is meant by **8**

i) Gradient ii) Divergence iii) Curl

Give their physical interpretation. Give the application of each in electric and magnetic field.

3. a) Derive electric field intensity due to infinitely long uniform line change density ρ_h c / m. **8**

b) Three infinite uniform sheets of change are located in free space as follows: **8**

$3n\,c/m^2$ at $z = -4$

$6n\,c/m^2$ at $z = 1$

$-8nc/m^2$ at $z = 4$

Find $\bar{E}$ at the point:

i) $P_A(2,5,-5)$ ii) $P_B(4,2,-3)$ iii) $P_C(-1,-5,2)$

OR

4. Evaluate both sides of divergence theorem for the region bounded by $\rho = 2, \phi = 0, \phi = \pi, z = 0, z = 5$ for the given field: **16**

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

5. The magnetic field intensity in a certain region of space is given as **16**

$$\overline{H} = \left(\frac{x+2y}{z^2}\right)\hat{a}_y + \left(\frac{2}{z}\right)\hat{a}_z \; A/m$$

Solve both sides of Stoke's theorem to evaluate the current passing through the surface z = 4, $1 \le x \le 2$ and $3 \le y \le 5$ in the $\hat{a}_z$ direction.

OR

6. a) Explain: **8**
   i) Biot – Savart Law. ii) Ampere's circuital Law.

   b) Given the potential field $v = 5x^2yz + ky^3z$ volts. **8**
   a) Determine K so that Laplace equation is satisfied.
   b) For this value of k, specify the direction of $\overline{E}$ at (2, 1, -1) by a unit vector.

7. a) In a region $\sigma = 0, \in = 2.5\in_0, \mu = 10\mu_0$, Determine whether following pairs of fields satisfy Maxwell's equation $\overline{B} = (-754z - 4.52 \times 10^{10} t)\hat{a}y$ **8**

   b) Show that the time varying magnetic fields satisfy the equation $\overline{V} \times \overline{H} = \overline{J} + \frac{\partial \overline{D}}{\partial t}$. **8**
   Assume equation $\overline{V} \times \overline{H} = \overline{J}$ for the steady magnetic field.

OR

8. a) Derive continuity equation for time varying field and note on displacement current density. **8**

   b) Determine the amplitude of displacement current density. **8**
   i) In air near a car antenna, where the field of an FM signal is
   $\overline{E} = 80\cos(6\cdot277 \times 10^8 t - 2\cdot092y)\,\hat{a}_z \; V/m$
   ii) In an air space within a transformer where $\overline{H} = 10^6 \cos(377t + 1.2566 \times 10^{-6} z)$

9. a) Derive the wave equation for magnetic field intensity in general conducting medium. **8**

   b) State and prove Poynting vector theorem. **8**

OR

10. a) Write short notes on: **8**
   i) Slain Effect. ii) Depth of penetration

   b) Show that characteristic wave impedance of a uniform plane wave is given by **8**

$$\eta = \sqrt{\frac{j\omega\mu}{\sigma + j\omega\in}}$$

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