B.E. Fourth Semester (Electronics Engineering / Electronics Telecommunication Engineering / Electronics Communication Engineering) (C.B.S.)

Electromagnatic Fields Paper – III

P. Pages : 4 **KNT/KW/16/7270/7275**

Time : Three Hours * 0 1 4 0 * 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. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) The vector field is given as $\vec{W} = 4x^2y\,\vec{a}_x - (7x + 2z)\,\vec{a}_y + (4xy + 2z^2)\vec{a}_z$. **6**

a) What is the magnitude of field at P(2, -3,4).

b) Give a unit vector that shows the direction of field at p.

c) At what point or points on Z axis is the magnitude of $\vec{W}$ equal to unity?

b) Four infinite sheets of charge are located as follows: **7**

$20\,pc/m^2$ at y = 7, $-8pc/m^2$ at y = 3.

$6pc/m^2$ at y = -1 and $-18pc/m^2$ at y = - 4

Find $\vec{E}$ at (a) (2, 6, 4) (b) (0,0,0), (c) (-1, -1.1, 5) (d) $(10^6, 10^6, 10^6)$.

OR

2. a) **7**

Given $\vec{D} = \frac{10\rho^3}{4}\vec{a}_\rho \; c/m^2$ in cylindrical system. Evaluate both sides of divergence theorem for the volume enclosed by $\rho = 1$, $\rho = 2$, Z = 0 and Z = 10.

b) Find the volume charge density that is associated with each of the following fields. **6**

a) $\vec{D} = xy^2\,\vec{a}_x + yx^2\,\vec{a}_y + z\,\vec{a}_z \; c/m^2$.

b) $\vec{D} = \rho z^2 \sin^2\phi\,\vec{a}_\rho + \rho z^2 \sin\phi\cos\phi\,\vec{a}_\phi + \rho^2 z \sin^2\phi\,\vec{a}_z \; c/m^2$.

c) $\vec{D} = \vec{a}_r \; c/m^2$.

3. a) Derive the expression for magnetic field intensity due to an in finite filament carrying current I in it. **6**

b) State and prove Ampere's circuital law. **7**

OR

4. a) **8**

Let $\vec{H} = -y(x^2 + y^2)\vec{a}_x + x(x^2 + y^2)\vec{a}_y$ A / m in Z = 0 plane for $-5 \le x \le 5, -5 \le y \le 5.$

Find the total current passing through Z = 0 plane in $\vec{a}_z$ direction inside the rectangle $-1 \le x \le 1$ and $-2 \le y \le 2$ by ampere's circuital law and also by Stoke's theorem.

b) State and explain Stoke's theorem. **5**

5. a) Prove that the Maxwell's equation for magnetic field is given by - $\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$. **7**

b) A material for which $\Sigma r = 1.5,\ \mu_r = 1$ has conductivity σ. **7**

Let $\vec{E} = 60\cos(10^5 t)\,\vec{a}_x$ v/m. find (a) $\vec{J}_c$ (b) $\vec{J}_d$. (c) The conductivity for which the displacement current density and conduction current density have equal amplitudes.

OR

6. a) Show that at a boundary between two conducting media the tangential component of electric field intensity is continuous. **6**

b) Select the value of K such that each of the following pairs of fields satisfies Maxwell's equations in the region where $\sigma = 0$ and $\rho_v = 0$. **8**

a) $\vec{E} = (kx - 100t)\,\vec{a}_y$ v / m;

$\vec{H} = (x + 20t)\,\vec{a}_z$ A / m;
$\mu = 0.25$ H / m. $\Sigma = 0.01$ F / m.

b) $\vec{D} = 5x\,\vec{a}_x - 2y\,\vec{a}_y + kz\,\vec{a}_z\ \mu c / m^2$;

$\vec{B} = 2\,\vec{a}_y$ mT; $\mu = \mu_o; \Sigma = \Sigma_o$.

c) $\vec{E} = 60\sin(10^6 t)\sin(0.01z)\,\vec{a}_x$ V / m;

$\vec{H} = 0.6\cos(10^6 t)\cos(0.01z)\,\vec{a}_y$ A / m :
$\mu = k, \varepsilon = C_1$

7. a) A 9.4 GH_Z uniform plane wave is propagating in polyethylene **7**

$\left(\varepsilon_r = 2.26, \frac{\sigma}{\omega\varepsilon} = 0.0002 \approx 0\right)$.

If the amplitude of magnetic field intensity is 7mA/m and the material is assumed to be lossless, find-

a) The velocity of propagation.

b) The wavelength

c) The phase constant

d) Intrinsic Impedance.

e) The amplitude of electric field intensity.

b) Prove that an intrinsic impedance of the medium is given by – **6**

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

OR

8. a) State and prove Poyntings vector theorem. **7**

b) A uniform plane wave with an electric field intensity amplitude of 400v/m is incident from free space normally on a dielectric with $\varepsilon_r = 9$. Find the reflected and transmitted $\vec{E}$ & $\vec{H}$. **6**

9. a) Explain why TEM wave cannot exist in rectangular wave guide. **4**

b) What is phase velocity? Derive an expression for phase velocity of wave in rectangular waveguide. **4**

c) A rectangular waveguide with dimensions of (5 x 2) cm is used to transmit a signal of 5 GH_Z. Determine the cut-off frequency for TE_{10} mode. Also find phase velocity and group velocity for TE_{10} mode. **5**

OR

10. a) What is wave impedance? Derive the expression for wave impedance for TM waves. **6**

b) A rectangular waveguide has dimension of (3 x 2) cm is used to transmit a signal of 9 GH_Z. Determine cut-off wavelength for dominant mode. Also find (i) Guide wavelength (ii) Group velocity (iii) Phase velocity (iv) Wave impedance (v) Phase constant. **7**

11. a) Write a short note on 'Retarded Magnetic Vector Potential'. **5**

b) Define the following terms related to an antenna; **9**

i) Antenna Efficiency ii) Front to Back ratio

iii) Radiation intensity iv) Directive gain.

v) Beam-width vi) Effective area.

OR

12. Prove that the radiation resistance of an infinitesimal current carrying element is given by **14**

$$R_{rad} = 80\,JL^2\left(\frac{d\ell}{\lambda}\right)^2.$$

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