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

Electromagnetic Fields

P. Pages : 3 **NKT/KS/17/7270/7275**

Time : Three Hours 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) Given vectors from the origin $\bar{r}_A = 3\bar{a}_x + 8\bar{a}_y + \bar{a}_z$, $\bar{r}_B = \bar{a}_x - 6\bar{a}_y + 5\bar{a}_z$ and $\bar{r}_C = 7\bar{a}_x - 4\bar{a}_z$, find : **6**

i) Unit vector perpendicular to both $\bar{r}_A$ and $\bar{r}_B$.

ii) The area of triangle defined by vectors $\bar{r}_A$, $\bar{r}_B$ and $\bar{r}_C$

b) In free space, let $Q_1 = 10\,\text{nc}$ be at $P_1(0, -4, 0)$ and $Q_2 = 20\ \text{nc}$ be at $P_2(0, 0, 4)$ **7**

i) Find $\vec{E}$ at the origin

ii) Where should a 30 nc point charge be located so that $\bar{E} = 0$ at the origin ?

OR

2. a) State and prove 'Gauss's' Law. **6**

b) State divergence theorem. **7**

Given the flux density $\bar{D} = \left(\frac{2\cos\theta}{r^3}\right)\bar{a}_r + \left(\frac{\sin\theta}{r^3}\right)\bar{a}_\theta\ c/m^2$

evaluate both sides of the divergence theorem for the region defined by 1 < r < 2, $0 < \theta < \pi/2$, $0 < \phi < \pi/2$.

3. a) What do you understand by displacement current density? Derive continuity equation for the time varying fields. **7**

b) Find the vector magnetic field intensity in Cartesian co-ordinates at $P_2(1.5, 2, 3)$ caused by a current filament at 24A in the $\bar{a}_z$ direction on the z-axis and extending from **7**

i) z = 0 to z = 6

ii) z = 6 to z = ∞

iii) z = $-\infty$ to z = ∞

OR

4.	a)	State and explain Biot-Savart law and Ampere circuital law.	**7**
	b)	Given the field $\overline{H} = 6r\sin\phi\,\bar{a}_r + 18r\sin\theta\cos\phi\,\bar{a}_\phi$, evaluate both sides of Stoke's theorem for the portion of the cone $\theta = 0.1\pi$ bounded by r = 2, r = 4, $\phi = 0$ and $\phi = 0.3\pi$. Let the direction of $d\bar{s}$ be + $\bar{a}_\theta$.	**7**
5.		Derive equation for time varying field in point form and integral form.	**13**

OR

6.	a)	Obtain boundary condition at the interface of two perfect dielectric material for electric field.	**6**
	b)	In the region where $\sigma = 0$, $\varepsilon = 2.5\varepsilon_0$, $\mu = 10\mu_0$, determine whether following pair of fields satisfy Maxwell's equations : i) $\vec{E} = 2y\bar{a}_y$; $\vec{H} = 5x\,\vec{a}_x$ ii) $\vec{E} = 100\sin(6\times10^7 t)\sin z\,\vec{a}_y$ $\vec{H} = -0.1328\cos(6\times10^7 t)\cos z\,\vec{a}_x$	**7**
7.	a)	What do you mean by skin effect ? Define skin depth. Show that in case of semi infinite solid conductor, the skin depth δ is given by $\delta = \sqrt{\dfrac{2}{\text{cosec}6}}$ Symbols have their usual meaning.	**7**
	b)	State and prove pointing theorem.	**6**

OR

8.	a)	State and prove the law of reflaction and refraction when a uniform plane wave in one dielectric is obliquely incident upon another dielectric.	**6**
	b)	A uniform plane wave with an electric field intensity of 400 V/m is incident from free space normally to a dielectric with $\in_r = 9$. Find the reflected and transmitted $\overline{E}$ and $\overline{H}$ fields.	**7**
9.	a)	Define various modes in waveguides. Explain what is meant by the dominant mode in a waveguide. Find expression for the cut off frequency for the dominant mode in hollow rectangular waveguide.	**7**
	b)	What is wave impedance ? Derive the expression for wave impedance for TE wave in rectangular waveguide.	**7**

OR

10.	a)	Prove that the geometric mean of phase velocity and group velocity is equal to velocity of light.	**8**

b) A rectangular waveguide with dimension of a = 2cm and b = 1cm filled with deionized water $(\mu_r = 1, \in_r = 81)$ operates at 3 GHz. Determine all the propagating mode and the corresponding cutoff frequencies. **6**

11. a) Explain the following terms - **8**

i) Antenna efficiency
ii) Radiation intensity
iii) Directivity
iv) Front to back ratio

b) Explain the concept of 'Retarded magnetic vector potential'. **5**

OR

12. Show that the radiation resistance of a current element is given by - **13**

$$R_{rad} = 80\ \pi^2 \left(\frac{dl}{\lambda}\right)^2$$

Where R_{rad} = Radiation resistance
dl = Length of current element.

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