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

# Electromagnetic Fields

P. Pages : 3 **NRJ/KW/17/4410/4415**

Time : Three Hours * 0 1 9 3 * Max. Marks : 80

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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 points A (2, 5, -1), B (3, -2, 4) and C (-2, 3, 1) find **6**

i) $\vec{R}_{AB} \cdot \vec{R}_{AC}$

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

iii) The length of projection of $\vec{R}_{AB}$ on $\vec{R}_{AC}$

iv) The vector projection of $\vec{R}_{AB}$ on $\vec{R}_{AC}$.

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

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

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

Find $\vec{E}$ at

i) (2, 6, 4) ii) (0, 0, 0)

iii) (–1, -1.1, 5) iv) $(10^6, 10^6, 10^6)$

**OR**

**2.** a) Derive an expression for electric field Intensity at any point due to infinite line charge along z axis. **6**

b) Given the flux density $\vec{D} = \frac{2\cos\theta}{r^3}\,\hat{a}r + \frac{\sin\theta}{r^3}\,\hat{a}\theta\ c/m^2$. Evaluate both sides of divergence theorem for the region defined by $1 < r < 2$, $0 < \theta < \pi/2$, $0 < \phi < \pi/2$. **7**

**3.** a) State and Explain Biot Savart law. **7**

b) Find the vector magnetic field Intensity in Cartesian coordinate at point (1.5, 2, 3) caused by the current filament of 24A in $a\hat{z}$ direction on z axis and extending from **7**

i) $z = 0$ to $z = 6$

ii) $z = 6$ to $z = \infty$

iii) $z = -\infty$ to $z = \infty$

**OR**

**4.** a) Derive the continuity equation $\nabla \cdot J = -\frac{\partial}{\partial t}\rho v$. **7**

b) State and Explain Ampere's circuital law and stoke's theorem. **7**

**5.** Derive Maxwell's equation for time varying field in point form and Integral form. **13**

**OR**

**6.** a) Write short note on conduction current and Displacement current densities. **6**

b) Select the value of k such that each of the following pairs of fields satisfies Maxwell's equation in the region where **7**

$\sigma = 0$ and $\rho_v = 0$

i) $\vec{E} = (kx - 100t)\, a\hat{y}\ v/m$

$\vec{H} = (x + 20t)\, a\hat{z}\ A/m$

$\mu = 0.25 H/m$, $\in = 0.01\ F/m$.

ii) $\vec{D} = 5x\, \hat{ax} - 2y\, \hat{ay} + kz\, \hat{az}\ \mu c/m^2$

$\vec{B} = 2\, \hat{ay}\ mT$

$\mu = \mu_0$

$\varepsilon = \varepsilon_0$

**7.** a) Prove that an intrinsic impedance of the medium is **7**

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

b) A 9375MHz uniform plane wave is propagating in polystyrene having $\varepsilon_r = 2.56$. If the amplitude of $\bar{E}$ is 20V/m and the material is assumed to be lossless. Find **6**

i) The phase constant

ii) The wavelength in polystyrene

iii) The velocity of propagation

iv) The intrinsic impedance

v) The propagation constant

vi) The amplitude of magnetic field intensity

**OR**

**8.** a) State and derive Poynting vector theorem. **7**

b) A plane wave of 200MHz travelling in free space impinges normally on a large block of material having $\varepsilon_r = 4, \mu_r = 9, \sigma = 0$ Determine $\eta_1, \eta_2, \beta_1, \beta_2$, reflection coefficient and transmission coefficient. **6**

**9.** a) Derive the Expression for Rectangular waveguide. **7**

$$\lambda_g = \frac{\lambda}{\sqrt{1-(\lambda/\lambda_c)^2}}$$

b) A hollow rectangular waveguide has inner dimensions $7\text{cm} \times 4\text{cm}$ find cut off freq. in $T_{E01}, T_{E10}, T_{E11}$ mode. **6**

**OR**

**10.** a) Derive the Expression for group velocity and phase velocity in Rectangular waveguide. **8**

b) What will be the cut off wavelength for dominant mode in rectangular waveguide whose breadth s 10cm for 2.5 GHz signal, Calculate. **5**

i) Guide wavelength
ii) Group velocity
iii) Phase velocity
iv) Cut off frequency
v) Wave Impedance

**11.** a) Given that average power radiated by a current carrying element is $\frac{\eta}{2}\left(\frac{wI\,dl\sin\theta}{4\pi rc}\right)^2$. Find the expression for the total radiated power. Thus find radiation resistance. **9**

b) Explain the concept of "Retarded Magnetic Vector Potential". **5**

**OR**

**12.** a) Define the following terms. **8**

i) Radiation Intensity
ii) Directive Gain
iii) Power Gain
iv) Beam Width
v) Front to Back Ratio
vi) Antenna Efficiency

b) A monopole antenna of height 10cms operate at a frequency of 300MHz and is situated above ground. Find its radiation resistance. **6**

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