



Third Semester B.E. Degree Examination, June/July 2015
Field Theory

Time: 3 hrs.

Max. Marks: 100

**Note: Answer FIVE full questions, selecting
at least TWO questions from each part.**

PART - A

1.
 - a. State and prove Gauss law. (04 Marks)
 - b. Find the volume charge density at $(4\text{m}, 45^\circ, 60^\circ)$. If the electric flux density is given by, $\vec{D} = (r \hat{a}_r + \sin\theta \hat{a}_\theta + \sin\theta \cos\phi \hat{a}_\phi)$ C/m². (06 Marks)
 - c. Given $\vec{D} = \frac{10r^3}{4} \hat{a}_r$ in cylindrical co-ordinates, evaluate both sides of the divergence theorem for the volume enclosed by the cylinder with $r = 2\text{m}$, $z = 0$ to 10m . (10 Marks)
2.
 - a. With usual notations, prove point form of continuity equation, $\nabla \cdot \vec{J} = \frac{\partial \rho_v}{\partial t}$. (05 Marks)
 - b. Find the amount of energy required to move a 6 coulomb of point charge from the origin to $P(3, 1, -1)\text{m}$ in the field $\vec{E} = (2x \hat{a}_x - 3y^2 \hat{a}_y + 4z \hat{a}_z)$ V/m along the straight line path, $x = -3z$, $y = x + 2z$. (05 Marks)
 - c. A parallel plate capacitor is filled with a dielectric of 0.03 power factor and $\epsilon_r = 10$. The plates have an area of 250mm^2 and the distance between them is 10mm . If 5000V (rms) at 1MHz is applied to the capacitor find the power dissipated as heat. (10 Marks)
3.
 - a. Find V and the volume charge density in free space, if $V = \frac{2 \cos \phi}{r^2}$ at $P(0.5, 45^\circ, 60^\circ)$. (07 Marks)
 - b. Find the electric field at $P(3, 1, 2)$ for the field of two radial conducting planes $V = 50\text{V}$ at $\phi = 10^\circ$ and $V = 20\text{V}$ at $\phi = 30^\circ$. (08 Marks)
 - c. State and prove uniqueness theorem. (05 Marks)
4.
 - a. State and prove Ampere's law. (04 Marks)
 - b. Calculate the magnetic field intensity at point P due to 10A current flowing in the anticlockwise direction in the metallic block shown in Fig. Q4 (b). (06 Marks)

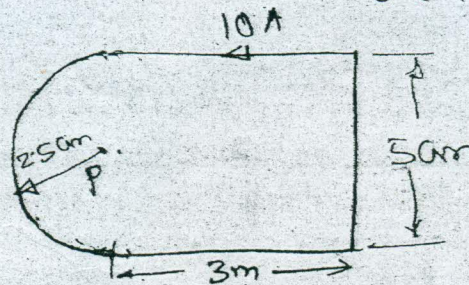


Fig. Q4 (b)

- c. Verify Stokes theorem for a field having $\vec{H} = 2\rho^2(\tau+1)\sin\phi \hat{a}_\phi$ for the portion of a cylindrical surface defined by $\rho = 2$, $\frac{\pi}{4} \leq \phi \leq \frac{\pi}{2}$, $1 \leq \tau \leq 1.5$ and for its perimeter. (10 Marks)

**PART - B**

- 5 a. What is Lorentz force equation? (02 Marks)
b. A square loop carrying 2 mA current is placed in the field of an infinite element carrying current of 15 A as shown in Fig. Q5 (b). Find the force exerted on the loop. (08 Marks)

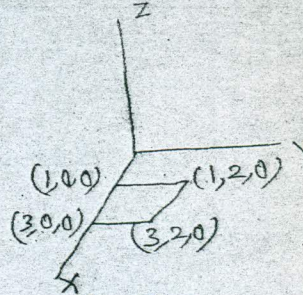


Fig. Q5 (b)

- c. Two homogeneous, linear, isotropic material have interface at $X = 0$, in which there is a surface current $K = 200\hat{a}_z$ A/m. In region 2 for $X > 0$, find i) H_2 ii) $|B_1|$ iii) $|B_2|$ iv) α_1 v) α_2 . If $H_1 = (150\hat{a}_x - 400\hat{a}_y + 250\hat{a}_z)$ A/m. (10 Marks)
- 6 a. State Maxwell's equations for a good conductor and for perfect dielectrics. (08 Marks)
b. Define phase velocity, wavelength and propagation constant. (06 Marks)
c. A uniform plane wave traveling in +z direction in air has $H = 20\hat{a}_y$ A/m the frequency of the signal is $\frac{1}{\pi} \times 10^9$ Hz. Find λ , T and E. (06 Marks)
- 7 a. Derive the expression for α , β , γ and V for low loss dielectric. (06 Marks)
b. For a uniform plane wave, $E_y = 10.4e^{(-j\beta x + 2\pi \times 10^8 t)}$ V/m. Find
i) The direction of propagation.
ii) Phase constant β
iii) Expression for H. (05 Marks)
c. A material is characterized by $\epsilon_r = 2.5$, $\mu_r = 1$ and $\sigma = 4 \times 10^{-5}$ S/m at $f = 1$ MHz. Determine the value of the loss tangent, attenuation constant and phase constant. (09 Marks)
- 8 Write an explanatory notes on:
a. Standing wave ratio. (08 Marks)
b. Poynting vector. (12 Marks)
