

CBCS Scheme

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15EC36

Third Semester B.E. Degree Examination, Dec.2016/Jan.2017 Engineering Electromagnetics

Time: 3 hrs.

Max. Marks: 80

**Note: Answer any FIVE full questions,
choosing ONE full question from each module.**

Module-1

- 1 a. Point charges of 50 nano-coulomb each are located at A(1, 0, 0), B(-1, 0, 0), C(0, 1, 0) and D(0, -1, 0) in free space. Find the total force on the charge at A. (08 Marks)
- b. Define electric field intensity and electric flux density. (04 Marks)
- c. A uniform line charge of infinite length with $\rho_L = 40$ nc/m lies along z axis. Find \vec{E} at (-2, 2, 8) in air. (04 Marks)

OR

- 2 a. Derive the expression for electric field intensity due to infinite line charge. (08 Marks)
- b. Two particles having charges 2 nano-coulomb and 5 nano-coulomb are spaced 80 cm apart. Determine the electric field intensity at point "A" situated at a distance of 0.5 m from each of the two particles. Assume dielectric constant of 5. (08 Marks)

Module-2

- 3 a. Evaluate both sides of the divergence theorem for the field $\vec{D} = 2xy \hat{a}_x + x^2 \hat{a}_y$ /m² and the rectangular parallel piped formed by the planes $x = 0$ and 1, $y = 0$ and 2, and $z = 0$ and 3. (08 Marks)
- b. Derive the expression for equation of continuity. (06 Marks)
- c. Give the vector density $\vec{J} = 10\rho^2 z \hat{a}_\rho - 4\rho \cos^2 \phi \hat{a}_\phi$ mA/m². Determine the total current flowing outward through the circular band. $\rho = 3$, $0 < \phi < 2\pi$, $2 < z < 2.8$. (02 Marks)

OR

- 4 a. State and explain Gauss law in point form. (05 Marks)
- b. Given the electric field $\vec{E} = 2x \hat{a}_x - 4y \hat{a}_y$ v/m. Find the work done in moving a point charge +2C from (2, 0, 0,) to (0, 0, 0) and then form (0, 0, 0) to (0, 2, 0). (05 Marks)
- c. A potential field in free space is expressed as $V = \frac{60 \sin \theta}{r^2}$ v. Find the electric flux density at the point (3, 60°, 25°) in spherical co-ordinates. (06 Marks)

Module-3

- 5 a. State and explain uniqueness theorem. (08 Marks)
- b. Determine the magnetic field intensity \vec{H} at point P(0.4, 0.3, 0), if the 8A current in a conductor inward from infinity to origin on the x axis and outward to infinity along y axis. (08 Marks)

OR

- 6 a. Find the potential and volume charge density at P(0.5, 1.5, 1)m in free space given the potential field $V = 6\rho\phi Z$ volts. (08 Marks)
- b. Explain the concepts of scalar and vector magnetic potential. (08 Marks)

Module-4

- 7 a. Derive an equation for the magnetic force between two differential current elements. (06 Marks)
- b. Find the magnetization in a material where : i) $\mu = 1.8 \times 10^{-5}$ H/m and $H = 120$ A/m
ii) $\mu_r = 22$. There are 8.3×10^{28} atom/m³ and each atom has a dipole moment of 4.5×10^{-27} A/m². iii) $B = 300$ μ T and $X_{on} = 15$. (06 Marks)
- c. A conductor 4m long lies along the y axis with a current of 10A in the \overline{ay} direction. Find the force on the conductor if the field in the region is $\overline{B} = 0.005ax$ Tesla. (04 Marks)

OR

- 8 a. Find the expression for force on differential current element moving in a steady magnetic field. Deduce the result to a straight conductor in a uniform magnetic field. (08 Marks)
- b. For region 1, $\mu_1 = 4\mu$ H/m and for region 2, $\mu_2 = 6\mu$ H/m. The regions are separated by $z = 0$ plane. The surface current density at the boundary is $\overline{K} = 100ax$ A/m. Find \overline{B}_2 if $\overline{B}_1 = 2\hat{a}_x - 3\hat{a}_y + \hat{a}_z$ militesla for $z > 0$. (08 Marks)

Module-5

- 9 a. For the given medium $\epsilon = 4 \times 10^{-9}$ F/m and $\sigma = 0$. Find 'K' so that the following pair of fields satisfy Maxwell's equation :
 $\overline{E} = (20y - kt)a_x$ v/m (08 Marks)
 $\overline{H} = (y + 2 \times 10^6 t)a_z$ A/m
- b. A plane wave of 16 GHz frequency and $E = 10$ v/m propagates through the body of salt water having constants $\epsilon = 100$, $\mu_r = 1$ and $\sigma = 100$ S/m. Determine attenuation constant, phase shift, phase velocity and intrinsic impedance of the medium and depth of penetration. (08 Marks)

OR

- 10 a. State and explain Poynting theorem. (08 Marks)
- b. Find the amplitude of displacement current density in the free space within a large power distribution transformer where $\overline{H} = 10^6 \cos(377t + 1.2566 \times 10^{-6}z)\hat{ay}$ A/m. (05 Marks)
- c. The depth of penetration in a conducting medium is 0.1m and the frequency of the electromagnetic wave is 1 MHz. Find the conductivity of the conducting medium. (03 Marks)

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