

# CBCS SCHEME

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15EC36

## Third Semester B.E. Degree Examination, Dec.2019/Jan.2020 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. Define electric field intensity and electric flux density and derive the expression for D due to point charge. (05 Marks)
- b. Identical point charges of  $3\mu\text{C}$  are located at the four corners of the square of 5cm side, find the magnitude of force on any one charge. (08 Marks)
- c. On the line described  $x = 4\text{m}$ ,  $y = -2\text{m}$  there is uniform charge distribution of density  $\rho_l = 10\text{nc/m}$ . Find  $\vec{E}$  at  $(4, 2, -1)\text{m}$ . (03 Marks)

OR

- 2 a. State and explain Coulomb's law of force between two point charges in vector form and mention the units of quantities in the force equation. (08 Marks)
- b. Three point charges  $Q_1 = -1\mu\text{C}$ ,  $Q_2 = -2\mu\text{C}$  and  $Q_3 = -3\mu\text{C}$  are placed at the corners of an equilateral triangle of side 1m, find the magnitude of the electric field intensity at the point bisecting the line joining  $Q_1$  and  $Q_2$ . (08 Marks)

### Module-2

- 3 a. In the region  $r \leq 2$ ,  $\vec{D} = \frac{7r^2}{3} \hat{a}_r$  and in the region  $r > 2$ ,  $\vec{D} = \frac{120}{r^2} \hat{a}_r$  in spherical coordinate system calculate the charge density. (08 Marks)
- b. Derive the expression for continuity of current. (04 Marks)
- c. Derive Maxwell's first equation in electrostatic. (04 Marks)

OR

- 4 a. Obtain the boundary condition at the interface between a dielectric material and a conductor. (08 Marks)
- b. State and explain Gauss law in point form. (04 Marks)
- c. If the potential field  $V = 3x^2 + 3y^2 + 2z^3$  volts, find: i)  $V$  ii)  $E$  iii)  $\vec{P}$  at  $P(-4, 5, 4)$ . (04 Marks)

### Module-3

- 5 a. State and explain Biot-Savart's law. (05 Marks)
- b. Two parallel conducting discs are separated by distance 5mm at  $z = 0$  and  $z = 5\text{mm}$ . If  $v = 0$  at  $z = 0$  and  $v = 100\text{v}$  at  $z = 5\text{mm}$ , find the charge densities on the discs. (05 Marks)
- c. Using Poisson's equation obtain the expression for the junction potential in a p-n junction. (06 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

OR

- 6 a. Derive Laplace and Poisson's equation starting from the Gauss's law and also write Laplace's equation in Cartesian, cylindrical and spherical coordinate system. (08 Marks)
- b. Evaluate both sides of the Stoke's theorem for the field  $\vec{H} = 6xy \hat{a}_x - 3y^2 \hat{a}_y$  A/m and the rectangular path around the region  $2 \leq x \leq 5$ ,  $-1 \leq y \leq 1$ ,  $z = 0$  let the positive direction of  $\vec{ds}$  be  $\hat{a}_z$ . (08 Marks)

Module-4

- 7 a. Obtain the expression for reluctance in a series of magnetic circuits. (04 Marks)
- b. A point charge of  $Q = -1.2C$  has velocity,  $\vec{V} = (5\hat{a}_x + 2\hat{a}_y - 3\hat{a}_z)$  m/s. Find the magnitude of the force exerted on the charge if,
- $\vec{E} = -18\hat{a}_x + 5\hat{a}_y - 10\hat{a}_z$  v/m
  - $\vec{B} = -4\hat{a}_x + 4\hat{a}_y + 3\hat{a}_z$  T
  - Both are present simultaneously. (08 Marks)
- c. Two infinitely long straight conductors are located at  $x = 0$ ,  $y = 0$  and  $x = 0$ ,  $y = 10$  m. Both carry current of 10A in positive  $\hat{a}_z$  direction. Determine force experienced per meter between them. (04 Marks)

OR

- 8 a. State and explain Lorentz force equation. (08 Marks)
- b. Find the magnetization in a magnetic material where,
- $\mu = 1.8 \times 10^5$  (H/m) and  $M = 120$  (A/M)
  - $\mu_r = 22$ , there are  $8.3 \times 10^{28}$  atoms/m<sup>3</sup> and each atom has a dipole moment of  $4.5 \times 10^{-27}$  (A/m<sup>2</sup>) and
  - $B = 300\mu$ T and  $\chi_m = 15$ . (08 Marks)

Module-5

- 9 a. Starting from Maxwell's equation derive wave equation in E and H for a uniform plane wave travelling in free space. (08 Marks)
- b. A homogeneous material has  $\epsilon = 2 \times 10^9$  F/m and  $\mu = 1.25 \times 10^{-6}$  H/m and  $\sigma = 0$ . Electric field intensity is given as  $\vec{E} = 400 \cos(10^9 t - kz) \hat{a}_n$  v/m, if all the fields vary sinusoidally find  $\vec{D}$ ,  $\vec{B}$  and  $\vec{H}$ . Also find k using Maxwell's equations. (08 Marks)

OR

- 10 a. List Maxwell's equation in point form and integral form. (06 Marks)
- b. A 15GHZ plane wave travelling in a medium has an amplitude  $E_0 = 20$  v/m. Find phase velocity, propagation constant and impedance. Assume  $\epsilon_r = 2$  and  $\mu_r = 5$ . (06 Marks)
- c.  $8 \text{ watts/m}^2$  is the pointing vector of a plane wave travelling in free space. What is the average energy density? (04 Marks)

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