



USN

--	--	--	--	--	--	--	--	--	--

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019 Engineering Electromagnetics

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. State and explain Coulomb's law in complete form. (06 Marks)
- b. Two particles having charges $2nc$ and $5nc$ are spaced 80cm apart. Determine the \vec{E} at a point is situated at a distance of 0.5m from each of the two particles. Use $\epsilon_r = 5$. (Use Bakelite medium). (06 Marks)
- c. Identical point charges of $3\mu c$ are located at the four corners of the square of 5cm side, find the magnitude of the force on any one charge? (08 Marks)

OR

- 2 a. Derive expression for E due to infinite line charge from first principle. (08 Marks)
- b. Two uniform line charges of density $4n$ c/m and $6n$ c/m lie in $x = 0$ plane at $y = +5m$ and $-6m$ respectively. Find E at $(4, 0, 5)^m$. (06 Marks)
- c. Define E and D, Hence establish the relation between D and E. (06 Marks)

Module-2

- 3 a. State and prove Gauss divergence theorem. (06 Marks)
- b. If $D = \frac{5r^2}{4} \hat{a}_r$ c/m². (in spherical system) then evaluates both sides of the divergence theorem for the volume enclosed by $r = 4m$, and $\theta = \pi/4$ radians. (08 Marks)
- c. Prove that $\rho_v = \nabla \cdot D$. (06 Marks)

OR

- 4 a. Establish relation $E = -\nabla v$ (06 Marks)
- b. Electrical potential at an arbitrary point in free space is given as $V = (x+1)^2 + (y+2)^2 + (z+3)^2$ Volts at $p(2, 1, 0)$. Find :
 i) V ii) \vec{E} iii) $|\vec{E}|$ iv) $|\vec{D}|$ v) ρ_v (08 Marks)
- c. Derive continuity of current equation. (06 Marks)

Module-3

- 5 a. Derive Laplace and Poisson's equations and write Laplace Equation in all 3 co-ordinate systems. (08 Marks)
- b. State and prove uniqueness theorem. (07 Marks)
- c. Calculate the numerical values for V and ρ_v at P in free space if $V = \frac{4yz}{x^2 + 1}$ at $P(1, 2, 3)$. (05 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. An assembly of two concentric spherical shells is considered. The inner spherical shell is at a distance of 0.1m and is at a potential of 0 volts. The outer spherical shell is at a distance of 0.2m and at a potential of 100V. The medium between them is a free space. Find \bar{E} and \bar{D} using spherical co-ordinate system. (06 Marks)
- b. State and prove Ampers circuital law. (08 Marks)
- c. At a point P(x, y, z) the components of vector magnetic potential \bar{A} are given as
 $A_x = 4x + 3y + 2z$
 $A_y = 5x + 6y + 3z$ and
 $A_z = 2x + 3y + 5z$
Determine \bar{B} at point P and state its nature. (06 Marks)

Module-4

- 7 a. Derive an expression for the force on a differential current element placed in a magnetic field and deduce the result for straight conductor in a uniform magnetic field. (08 Marks)
- b. A point charge $Q = 18\text{nc}$ has a velocity of $5 \times 10^6 \text{ m/s}$ in the direction $\bar{a}_v = 0.6\hat{a}_x + 0.75\hat{a}_y + 0.3\hat{a}_z$.
Calculate the magnitude of the force exerted on the charge by the field
i) $\bar{E} = -3\hat{a}_x + 4\hat{a}_y + 6\hat{a}_z \text{ K v/m}$
ii) $\bar{B} = -3\hat{a}_x + 4\hat{a}_y + 6\hat{a}_z \text{ MT}$
iii) \bar{B} & \bar{E} acting together. (06 Marks)
- c. State and explain Lorentz force equation. (06 Marks)

OR

- 8 a. Define : i) Magnetization ii) Permeability. (04 Marks)
- b. If $\bar{B} = 0.05 \times \hat{a}_y \text{ T}$ in a material for which magnetic susceptibility $X_m = 2.5$. Find
i) μ_r ii) μ iii) \bar{H} iv) \bar{M} v) \bar{J}_c vi) \bar{J}_b (08 Marks)
- c. Discuss the boundary conditions at the interface between two media of different permeabilities? (08 Marks)

Module-5

- 9 a. Derive Maxwell's Equations in point form and Integral form for Time varying fields. (08 Marks)
- b. For a lossy dielectric $\sigma = 5 \text{ s/m}$, $\epsilon_r = 1$ the electric field intensity is $E = 100 \sin 10^{10} t$. Find J_c and J_d and frequency at which both have Equal Magnitudes. (04 Marks)
- c. Starting from Maxwell's Equation Derive the wave equation for a uniform plane wave travelling in free space. (08 Marks)

OR

- 10 a. State and prove Poynting theorem. (08 Marks)
- b. Deduce the expressions for α and β for a uniform plane wave propagation in good conducting medium. (06 Marks)
- c. Wet Marshy soil is characterized by $\sigma = 10^{-2} \text{ s/m}$, $\epsilon_r = 15$ and $\mu_r = 1$. At the frequencies 60Hz, 1 MHz, 100 MHz and 10 GHz indicate whether the soil may be considered a conducting dielectric or neither. (06 Marks)