CBCS SCHEME

USN | | | | | | | | | | 18EC55

Fifth Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026
Electromagnetic Waves

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 and represent the same in vector form. **(06 Marks)**

b. Define the following terms :
i) Electric field intensity
ii) Electric flux density **(06 Marks)**

c. A 20 nc point charge is located at P(2.4, –3) in free space. Find E(r) and E at A(–3, 2, 0). **(08 Marks)**

OR

2 a. Derive the expression for electric field intensity due to infinite line charge. **(08 Marks)**

b. A uniform line charge of infinite length with P_L = 40 nc/m lies along z-axis. Find $\vec{E}$ at (–2, 2, 8) in air. **(04 Marks)**

c. Two particles having charges 2nc and 5nc 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, $\epsilon = 5$. **(08 Marks)**

Module-2

3 a. State and explain Gauss law in point form. **(06 Marks)**

b. Derive the equation of continuity. **(06 Marks)**

c. Calculate the work done in moving a 4 nc charge from B(1, 0, 0) to A(0, 2, 0) along the path $y = z - 2x$, $z = 0$ in the field 'E'.
i) 5ax v/m ii) 5x ax v/m iii) 5x ax + 5y ay v/m. **(08 Marks)**

OR

4 a. State and prove Gauss Divergence theorem. **(06 Marks)**

b. Define the following terms :
i) Potential
ii) Potential difference. **(06 Marks)**

c. Let $v = \frac{\cos 2\phi}{r}$ in free space in cylindrical system.
i) Find $\overline{E}$ at B(2, 30°, 1)
ii) Find the volume charge density at point A(0.5, 60°, 1). **(08 Marks)**

Module-3

5 a. Derive the expression for Poisson's and Laplace equation from point form of Guass law in all the three coordinates system. **(06 Marks)**

b. Prove the uniquencess of solution using uniqueness theorem. **(08 Marks)**

c. Find V at (2, 1, 3) for the field of
i) 2 co-axial conducting cylinders v = 20V at p = 3m
ii) 2 concentric conducting sphere c = 50 V at r = 3 m and v = 20 V at r = 5 m. **(06 Marks)**

OR

6 a. State and explain Biot – Savart law. **(06 Marks)**

b. Explain the concept of scalar and vector magnetic potential. **(06 Marks)**

c. Find the magnetic field intensity with in magnetic material. Where
i) M = 180 A/m and $\mu = 1.8 \times 10^{-5}$ H/m
ii) $\overline{B} = 450\mu T$ and $x_m = 15$
iii) There are 8.3×10^{28} atoms/m^3 and each atom has a dipole moment 4.5×10^{-27} A-m^2 and $\mu_R = 22$. **(08 Marks)**

Module-4

7 a. Derive an equation for the magnetic force between two different current elements. **(08 Marks)**

b. Define the following terms :
i) Magnetization
ii) Permeability. **(06 Marks)**

c. Find the magnetization in a material, where
i) For which there are 3×10^{28} atoms/m^3 and each atom has equal dipole moment of 1.7×10^{-33} A/m^2
ii) $\mu_r = 1.00038$ and $\overline{H} = 0.25 A/m$
iii) $\overline{B} = 8 \times 10^{-5}$ Wb/m^3 and $x_m = -2 \times 10^{-4}$ **(06 Marks)**

OR

8 a. Derive the expression for force on a differential current element placed in a magnetic field. **(06 Marks)**

b. Obtain the boundary conditions at the interface between two media of different permeabilities. **(08 Marks)**

c. If B = 0.5 x ay T in a magnetic material for which $x_m = 2.5$. Find :
i) μ_R ii) μ iii) H iv) M v) J vi) J_b. **(06 Marks)**

Module-5

9 a. State and explain Faraday's law in point form and integral form. **(06 Marks)**

b. Write all Maxwell's equations in point form and integral form. **(06 Marks)**

c. Determine whether following pairs of fields satisfy Maxwell's equation in the region where $\sigma = 0$, $\varepsilon = 2.5\ \epsilon_0$, $\mu = 10\ \mu_0$ for $\vec{E} = 3yd\hat{y}$ and $\vec{H} = 4x\,a\hat{x}$. **(08 Marks)**

OR

10 a. Obtain the solution for a wave equation for a uniform plane wave in free space. **(08 Marks)**

b. State and prove poynting theorem. **(07 Marks)**

c. A 10 GHz plane wave travelling in free space has an amplitude 15v/m. Find ν_0, λ, η_0, β and amplitude of H. **(05 Marks)**

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