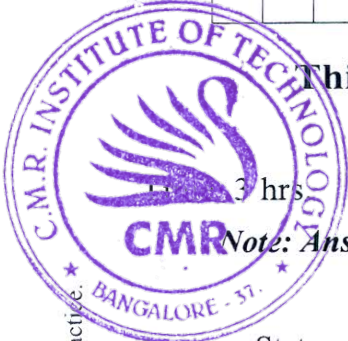


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Third Semester B.E. Degree Examination, Jan./Feb. 2023 Engineering Electromagnetics

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 of force between two point charges in vector form. (06 Marks)
- b. Q_1 and Q_2 are the point charges located at $(0, -4, 3)$ and $(0, 1, 1)$. If Q_1 is $2nC$, determine Q_2 such that force on a test charge at $(0, -3, 4)$ has no z-component. (07 Marks)
- c. Derive the expression for electric field intensity due to infinite line charge. (07 Marks)

OR

- 2 a. Define electric field Intensity. Derive an expression for electric field intensity due to 'n' number of point charges. (06 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 \bar{E} at $P(4, 0, 5)m$. (07 Marks)
- c. Define Electric flux and Electric flux density. Determine the flux crossing $\phi = \pi/4$ half plane defined by $0 \leq r \leq 3$ and $2 \leq z \leq 4$, given that $\bar{D} = \frac{r^2 z^2}{3} \cos\phi \bar{a}_\phi$. (07 Marks)

Module-2

- 3 a. State and prove Maxwell's first equation. (06 Marks)
- b. Given that $\bar{D} = \frac{5r^2}{4} \bar{a}_r$ c/m². Evaluate both sides of divergence theorem for the volume enclosed by $r = 4m$ and $\theta = \pi/4$. (07 Marks)
- c. Determine the potential difference between two points due to a point charge at origin. (07 Marks)

OR

- 4 a. State and explain Gauss's law. (06 Marks)
- b. Given that $V = \frac{\cos 2\phi}{r}$ in free space
 - i) Find \bar{E} at $p(2, 30^\circ, 1)$.
 - ii) Find volume charge density at $A(0.5, 60^\circ, 1)$. (07 Marks)
- c. Find an expression establishing the relationship between electric field and potential gradient. (07 Marks)

Module-3

- 5 a. State and prove uniqueness theorem. (08 Marks)
- b. If the field of a region in space is given by $\bar{E} = 5 \cos z \bar{a}_z$ v/m, is the region free of charge. (06 Marks)
- c. Obtain the expression for magnetic field intensity at a point due to a current carrying straight conductor of finite length. (06 Marks)

OR

- 6 a. State and prove Stoke's theorem. (08 Marks)
 b. Discuss the concept of vector magnetic potential and derive an expression for it. (06 Marks)
 c. Given the vector magnetic potential $\vec{A} = x^2\vec{a}_x + 2yz\vec{a}_y + (-x^2)\vec{a}_z$, find magnetic flux density. (06 Marks)

Module-4

- 7 a. Derive an equation for magnetic force between two differential current elements. (06 Marks)
 b. Define magnetization and permeability and explain with relevant expressions. (06 Marks)
 c. Find the normal component of the field traversed from medium 1 to medium 2 having $\mu_{r1} = 2.5$, $\mu_{r2} = 4$ given that $\vec{H}_1 = -30\vec{a}_x + 50\vec{a}_y + 70\vec{a}_z$ v/m. (08 Marks)

OR

- 8 a. State and explain Lorentz force equation. (06 Marks)
 b. Briefly explain the forces on magnetic materials. (06 Marks)
 c. A current element $I_1 d\vec{l}_1 = 10^{-4} \vec{a}_z$ Am is located at (2, 0, 0) and other element $I_2 d\vec{l}_2 = 10^{-6} (\vec{a}_x - 2\vec{a}_y + 3\vec{a}_z)$ Am is located at (-2, 0, 0). Both are in free space. Find:
 i) Force exerted on $I_2 d\vec{l}_2$ by $I_1 d\vec{l}_1$
 ii) Force exerted on $I_1 d\vec{l}_1$ by $I_2 d\vec{l}_2$. (08 Marks)

Module-5

- 9 a. What is uniform plane wave? Derive an expression of uniform plane wave travelling in free space. (07 Marks)
 b. Starting from equation of Faraday's law, obtain the point form of Maxwell's equation. Concerning spatial derivative of \vec{E} and time derivative of \vec{H} or prove that $\nabla \times \vec{E} = -\mu \frac{\partial \vec{H}}{\partial t}$. (07 Marks)
 c. Given $\vec{H} = Hm e^{j(\omega t + \beta z)} \vec{a}_x$ A/m in free space. Find \vec{E} . (06 Marks)

OR

- 10 a. State and prove Poynting's theorem. (07 Marks)
 b. Define displacement current density starting from the equation of ampere's circuital law, derive $\nabla \times \vec{H} = \vec{J}_C + \vec{J}_D$. (07 Marks)
 c. Calculate the intrinsic impedance η , the propagation constant γ , and wave velocity v for a conducting medium in which $\sigma = 58$ Ms/m, $\mu_r = 1$, $\epsilon_r = 1$ at a frequency of 100MHz. (06 Marks)
