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18EE45

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Electromagnetic Field Theory

Time: 3 hrs.

Max. Marks: 100

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

Module-1

- 1 a. Given : $\vec{A} = 2\hat{a}_x - \hat{a}_y + 3\hat{a}_z$ and $\vec{B} = -5\hat{a}_x - 6\hat{a}_y + 7\hat{a}_z$. Find $\vec{A} \times \vec{B}$ set's magnitude. (06 Marks)
- b. Derive relation between cylindrical and rectangular coordinate system. (06 Marks)
- c. State and prove coulomb's law in vector form. (08 Marks)

OR

- 2 a. Derive expression for electric field intensity due to several charges. (07 Marks)
- b. Calculate field intensity at point P(1, 2, 3) due to charge of 10nC at A(2, 3, 4). (07 Marks)
- c. State and prove Gauss law. (06 Marks)

Module-2

- 3 a. State that $E = -\nabla \cdot V$. (07 Marks)
- b. Given field intensity $E = 40xy\hat{a}_x + 20x^2\hat{a}_y + 2\hat{a}_z$, calculate the potential difference between two points P(1, -1, 0) and Q(2, 1, 3). (07 Marks)
- c. Derive expression for potential due to several point charges. (06 Marks)

OR

- 4 a. Derive an expression for continuity of current equation. (10 Marks)
- b. Find \vec{E} and \vec{J} considering the drift velocity of 60×10^{-4} m/s in the case of silver conductor using the data $\sigma_{\text{silv}} = 61.7 \times 10^6$ s/m and $\mu_{\text{sil}} = 5.6 \times 10^{-3}$ m²/vs. (10 Marks)

Module-3

- 5 a. Given $V = (Ar^4 + Br^{-4}) \sin 4\phi$, show that $\nabla^2 V = 0$. (07 Marks)
- b. Derive uniqueness theorem. (09 Marks)
- c. Verify the potential field $V = 2x^2 - 3y^2 + z^2$ satisfies the Laplace equation. (04 Marks)

OR

- 6 a. State and prove Amper's circuital law. (07 Marks)
- b. Given vector magnetic $\vec{A} = x^2\hat{a}_x - 2yz\hat{a}_y + (-x^2)\hat{a}_z$. Find magnetic flux density. (07 Marks)
- c. Calculate the value of vector circuit density at P(2, 3, 4) if $\vec{H} = x^2z\hat{a}_y - y^2x\hat{a}_z$. (06 Marks)

Module-4

- 7 a. Derive expression for the force between two parallel current carrying conductors. (07 Marks)
 b. Find torque on a square loop having at corner $(-2, -2, 0)$, $(2, -2, 0)$, $(2, 2, 0)$ and $(-2, 2, 0)$.
 i) About origin by $B = 0.4\hat{a}_x$
 ii) About origin by $B = 0.6\hat{a}_x - 0.4\hat{a}_y$
 iii) About origin by $B = 0.4\hat{a}_x + 0.6\hat{a}_y - 0.7\hat{a}_z$ take $I = 0.8A$. (08 Marks)
 c. If a point of $2C$ moves with a velocity of $(6\hat{a}_x + 3\hat{a}_y - 5\hat{a}_z)m/s$. Find force exerted :
 i) If electric field intensity is $(10\hat{u}_x + 8\hat{u}_y - 5\hat{u}_z)$
 ii) If flux density is $(5\hat{u}_x + 4\hat{u}_y + 6\hat{u}_z)wb/m^2$. (05 Marks)

OR

- 8 a. Magnetic flux density is given as $1.2T$ when $H = 300A/m$ when H is increased to $1500A/m$. The B is increased to $1.5T$ what is the percentage change in the magnetization vector. (07 Marks)
 b. Derive an expression for inductance of a solenoid. (06 Marks)
 c. Derive an expression for energy stored in a magnetic field. (07 Marks)

Module-5

- 9 a. List Maxwell's equations in differential form and integral form. (08 Marks)
 b. Derive expression for uniform plane wave propagating in free space. (12 Marks)

OR

- 10 a. Derive expression for pointing vector. (10 Marks)
 b. Explain and derive expression for skin depth. (10 Marks)

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