

CBCS Scheme

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15EE45

Fourth Semester B.E. Degree Examination, June/July 2017 Electromagnetic Field Theory

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. Define scalar and vector. For a given vectors $\vec{A} = 6\vec{a}_x + 2\vec{a}_y + 6\vec{a}_z$ and $\vec{B} = -2\vec{a}_x + 9\vec{a}_y - \vec{a}_z$.
- Show that vectors \vec{A} and \vec{B} are perpendicular to each other.
 - Find $\vec{A} \times \vec{B}$ and show $\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$. (06 Marks)
- b. Derive the relationship between rectangular and cylindrical coordinates. (05 Marks)
- c. Using surface integral obtain an expression for surface area of a sphere of radius 'r₁' meter. (05 Marks)

OR

- 2 a. State and prove Gauss law. (05 Marks)
- b. Two identical uniform line charges of line charge density 5 nC/m are parallel to x-axis are kept at z = 0, y = -2 m and z = 0, y = +4 m. Find the electric field at P(4, 1, 3) m. Assume free space conditions and infinite line charge. (06 Marks)
- c. If $\vec{D} = 2xy\vec{a}_x + 3yz\vec{a}_y + 4zx\vec{a}_z$ C/m², how much electric flux passes through that portion of the plane at x = 3 m for which $-1 \leq y \leq 2$ m and $0 \leq z \leq 4$ m. (05 Marks)

Module-2

- 3 a. Show that the electric field intensity (\vec{E}) can be expressed as negative gradient of scalar potential (V). (06 Marks)
- b. Find the work done in moving a point charge of Q = -20 μC from origin to P(4, 2, 0) along the path $x^2 = 8y$. Given $\vec{E} = 2(x+4y)\vec{a}_x + 8x\vec{a}_y$ V/m and $\epsilon = \epsilon_0$. (06 Marks)
- c. A point charge of 1 μC is at y = -3m and another point charge of 2 μC is at y = +3m. Find the electric potential at a point P(4, 0, 0)m. (04 Marks)

OR

- 4 a. With usual notations prove that $\nabla \cdot \vec{J} = -\frac{\partial \rho_v}{\partial t}$. (06 Marks)
- b. Derive an expression for capacitance of a parallel plate capacitor with a dielectric interface (ϵr_1 and ϵr_2) parallel to the conducting plates. (06 Marks)
- c. A parallel plate capacitor of 8.0 nF has an area of 1.51 m² and separation of 10 mm. What separation would be required to obtain the 10 nF capacitance between the plates? (04 Marks)

Module-3

- 5 a. Starting from Gauss's law in integral form, derive Poisson's and Laplace equation. Write Laplace equation in all the coordinate systems. (08 Marks)
- b. Obtain electric potential at a point between two parallel plates at z = 10 m and z = 5 m kept at potential of 60 Volts and 10 Volts respectively. Also find the electric field intensity at point. (08 Marks)

OR

- 6 a. Derive an expression for magnetic field intensity at a point due to an infinite long straight conductor carrying a current of I Amps along z-axis. (06 Marks)
- b. Evaluate both sides of stokes theorem for the field $\vec{H} = 10 \sin \theta \vec{a}_\phi$ Amperes/meter and the surface $r = 3\text{m}$, $0 \leq \theta \leq 90^\circ$, $0 \leq \phi \leq 90^\circ$. Let the surface has the \vec{a}_r direction. What each side of stokes theorem represents? (10 Marks)

Module-4

- 7 a. Derive an expression for the force between differential current elements. (08 Marks)
- b. A point charge of $Q = -40\mu\text{C}$ is moving with a velocity of $\vec{v} = (-3\vec{a}_x - 4\vec{a}_y + 4.5\vec{a}_z) \times 10^6$ m/sec. find the magnitude of the vector force exerted on the moving particle by the field:
- $\vec{B} = 2\vec{a}_x - 3\vec{a}_y + 5\vec{a}_z$ mT.
 - $\vec{E} = 2\vec{a}_x + 3\vec{a}_y - 4\vec{a}_z$ KV/m.
 - Both B and E acting together. (08 Marks)

OR

- 8 a. The $z = 0$ plane marks the boundary between two magnetic medium. Medium-1 is the region $z > 0$ and the medium-2 is the region $z < 0$. The magnetic flux density in the medium-1 is $\vec{B}_1 = 1.5\vec{a}_x + 0.8\vec{a}_y + 0.6\vec{a}_z$ mT. Find:
- The magnetic flux density in medium-2;
 - Angle between the magnetic flux density and the boundary between two magnetic medium. Assume $\mu_{r1} = 3$ and $\mu_{r2} = 4$. (07 Marks)
- b. Derive an expression for inductance of a solenoid. (04 Marks)
- c. A solenoid with air core has 2000 turns and a length of 500 mm. Core radius is 40 mm. Find its self inductance. (05 Marks)

Module-5

- 9 a. Write Maxwell's equations in point form and in integral form for time varying fields. (06 Marks)
- b. The circular loop conductor at $z = 0$ plane has a radius of 0.1 mt and resistance of 5Ω . Given $\vec{B} = 0.2 \sin 10^3 t \vec{a}_z$ Telsa. Find the current in the coil. (06 Marks)
- c. Derive continuity equation from Maxwell equation. (04 Marks)

OR

- 10 a. Starting from Maxwell's equations obtain the general wave equations in electric and magnetic fields. (08 Marks)
- b. A 50 GHz plane wave is travelling in a perfect dielectric medium has $E_0 = 20$ V/m. Find:
- Intrinsic impedence
 - Propogation constant
 - Velocity of wave
 - Magnetic field intensity.
- Given $\epsilon_r = 2$ and $\mu_r = 5$. (08 Marks)

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