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Question Paper Code : 81235

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2025.

Fourth Semester

Electronics and Communication Engineering

EC 3452 — ELECTROMAGNETIC FIELDS

(Common to : Electronics and Telecommunication Engineering)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Stoke's theorem and the Divergence theorem.
2. Verify whether the vector field $E = yz\vec{a}_x + xz\vec{a}_y + xy\vec{a}_z$ is solenoidal and irrotational.
3. Recall the principle of Superposition as applied to an electric potential of a point.
4. Mention the importance of Poisson's and Laplace's equation in electromagnetics with necessary equations.
5. Compute the torque on a magnetic dipole $M = 8 \times 10^{-3} \text{ A.m}^2$ placed in magnetic field $B = 0.2\hat{i} + 0.4\hat{j} \text{ Wb/m}^2$.
6. List the applications of Ampere's circuital law.
7. Analyze the materials in which both conduction and displacement current exist.
8. Formulate the significance of ratio of conduction current density and displacement current density.

9. Recall the expressions for propagation constant, intrinsic impedance if a wave propagates in a lossy dielectric.
10. Prove that the reflection coefficient is zero at Brewster angle.

PART B — (5 × 13 = 65 marks)

11. (a) Determine the curl and divergence of the given vector field

(i) $P = xyz\vec{a}_x + xy\vec{a}_y + yz\vec{a}_z$ (6)

(ii) $P = \frac{1}{r^2} \cos \theta \vec{a}_r + r \sin \theta \cos \theta \vec{a}_\theta$ (7)

Or

- (b) Evaluate both sides of the Stoke's theorem and Divergence theorem for the field, $A = 3y^2z\vec{a}_x + 6x^2y\vec{a}_y + 9xz^2\vec{a}_z$. The rectangular path around the edge of the region $0 < x < 2$, $-2 < y < 1$ and $0 < z < 1$.

12. (a) (i) Make use of Gauss's law to calculate the electric field due to an infinite line charge. (7)
- (ii) Given $Q_1 = 2 \text{ nC}$ at $(0, -4, 3)$ and test charge at $(0, -3, 4)$, find Q_2 at $(0, 1, 1)$ such that the net force on the test charge has no z-component. (6)

Or

- (b) (i) Discuss the boundary conditions of the normal and tangential components of electric field at the interface of two media with different dielectrics. (7)
- (ii) Obtain the formula for the electric field intensity of an infinite long straight line carrying uniform line charge density of ρ_L . (6)
13. (a) (i) From the Biot-Savart's law, obtain an expression for magnetic field intensity at a point P and distance R from the infinitely long straight current carrying conductor. (7)
- (ii) Distinguish between magnetic scalar and vector potentials with appropriate equations. (6)

Or

- (b) (i) Estimate the expression for inductance of a toroidal coil carrying current I, with N turns and the radius of toroid 'r'. (7)
- (ii) Examine the magnetic field intensity within a magnetic material where $M = 150 \text{ A/m}$ and $\mu = 1.5 \times 10^{-5} \text{ H/m}$. (6)

14. (a) Derive the Maxwell's equation for a time varying and modified for time varying from the fundamental laws of electric and magnetic fields.

Or

- (b) Deduce the detailed steps for the derivation of electromagnetic boundary conditions for a time varying fields.
15. (a) Explain the condition under which the magnitude of the reflection coefficient equals that of the transmission coefficient for a uniform wave at normal incidence on an interface between two lossless dielectric medium.

Or

- (b) Examine the expressions for the transmission and reflection coefficients at the interface of two media for normal incidence.

PART C — (1 × 15 = 15 marks)

16. (a) (i) Describe about the magnetic boundary condition at the interface between two magnetic media and derive the necessary boundary conditions. (8)
- (ii) Determine the magnetic field intensity at the origin due to current element, $Idl = 3\pi(\vec{a}_x + 2\vec{a}_y + 3\vec{a}_z)\mu A \cdot m$ at (3,4,5) m in free space. (7)

Or

- (b) (i) A cylindrical capacitor consists of an inner conductor of radius 'a' and an outer conductor whose inner radius is 'b'. The space between the conductors is filled with a dielectric permittivity ϵ_r and length of the capacitor is L. Estimate the value of the capacitance. (7)
- (ii) Derive the electric potential due to
- (1) a point charge,
 - (2) a line charge and
 - (3) a volume charge
- Derive the relation between \mathbf{E} and \mathbf{V} . (8)

1. The first step in the process of identifying a problem is to define the problem clearly and concisely.

2.

2. The second step is to gather information about the problem and its causes.

3. The third step is to analyze the information and identify the underlying causes of the problem.

3.

3. The fourth step is to develop a plan of action to address the problem.

4. The fifth step is to implement the plan and monitor progress.

4. The sixth step is to evaluate the results of the plan and make adjustments as needed.

5. The seventh step is to document the process and share the results with others.

5.

5. The eighth step is to reflect on the experience and learn from it.

6. The ninth step is to apply the lessons learned to other situations.

7. The tenth step is to continue to learn and grow.

8. The eleventh step is to seek feedback from others.

9. The twelfth step is to stay motivated and committed.

10. The final step is to celebrate success and share it with others.