

**B. ETCE 2<sup>ND</sup> YEAR 1<sup>ST</sup> SEMESTER EXAMINATION, 2025  
ELECTROMAGNETIC THEORY**

Time: 3 Hours

Full Marks: 100

**Answer any 4 unit out of 5 units: 4×25**

**UNIT- I  
FUNDAMENTALS**

**PART- A: Answer any 5 questions: 5 × 2=10**

1. What are the source of electric field and magnetic fields?
2. Give any three co ordinate systems.
3. Express the value of differential volume in rectangular and cylindrical Co-ordinate systems
4. What is physical significance of divergence of **D**.
5. Express the divergence of a vector in the three system of orthogonal Co-ordination.
6. State Divergence theorem.
7. State Stoke's theorem.
8. How is the unit vectors defined in three co ordinate systems?

**PART- B: 1×15=15**

Define divergence, gradient, curl in rectangular co-ordinate system with mathematical expression. Explain the physical significance of divergence of a vector field. Prove that divergence of a curl of a vector is zero using Stoke's Theorem.

6+4+5

OR

A field  $\mathbf{E} = r^2 \cos^2 \phi \mathbf{i}_r + z \sin \phi \mathbf{i}_\phi$  exists in the region  $0 \leq z \leq 1$  and  $r = 4$ . Verify the Divergence theorem for the configuration. Determine the scalar potential function  $V$ , whose negative gradient equals **A**. Where, **A** is expressed in spherical coordinate system.

10+5

**UNIT- II  
ELECTROSTATICS**

**PART- A: Answer any 5 questions: 5 × 2=10**

1. State coulombs law.
2. State Gauss law for electric fields
3. Define electric flux & electric flux density
4. Define electric field intensity
5. Name few applications of Gauss law in electrostatics
6. Define potential difference.

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7. Give the relation between electric field intensity and electric flux density.
8. Give the relationship between potential gradient and electric field.

**PART- B: 1×15=15**

Using the Gauss's law in differential form, obtain the electric field intensity at different point due to the following charge distribution in spherical coordinates. Derive the necessary relation you use.

$$\rho(r, \theta, \phi) = [\rho_0 \left(\frac{r}{a}\right)] \text{ for } 0 < r < a \text{ and } 0 \text{ for } a < r < \infty$$

OR

Discuss about the image theory. Consider a point charge  $Q$  placed at a distance  $h$  from a perfect conducting plane of infinite extent. Obtain the image charge.

5+10

**UNIT- III  
MAGNETOSTATICS**

**PART- A: Answer any 5 questions: 5 × 2=10**

1. State Ampere circuital law
2. Write the relation between magnetic flux density and field intensity
3. Define magnetic flux density
4. Give the force on a current element.
5. Define magnetic moment.
6. State Gauss law for magnetic field.
7. Give torque on closed circuits
8. Define magnetization.

**PART- B: 1×15=15**

Find the magnetic field intensity at  $P(0,6,0)$  in rectangular coordinate system caused by a current of  $24\pi$  A along  $z$  axis. The conductor extends from  $z = -8$  to  $8$ . Derive the necessary relation you use.

OR

Consider a current carrying loop in a uniform magnetic field. Find the total force and total torque on the loop.

**UNIT- IV  
ELECTRODYNAMIC FIELDS**

**PART- A: Answer any 5 questions: 5 × 2=10**

1. State Faraday's law of induction.
2. State lenz's law
3. Give the equation of transformer e.m.f.
4. What is motional electric field?

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5. What is motional e.m.f ?
6. What is the e.m.f produced by moving loop in time varying field?
7. What is significance of displacement current density?
8. What are the different ways of EMF generation?

**PART- B: 1×15=15**

With necessary explanation, derive the Maxwell's equation in differential and integral forms

OR

What do you mean by displacement current? Write down the expression for the total current density. Determine the capacitance of the capacitor per unit length of a coaxial cable.

**UNIT- V  
ELECTROMAGNETIC WAVES**

**PART- A: Answer any 5 questions: 5 × 2=10**

1. Mention the properties of uniform plane wave.
2. Write down the wave equation for E and H in free space.
3. Calculate the characteristic impedance of free space.
4. Define propagation constant.
5. Define skin depth.
6. Define Poynting vector.
7. What is lossy dielectric medium?
8. Define loss less dielectric medium
9. Define Circular Polarization.

**PART- B: 1×15=15**

Consider a electromagnetic wave with  $E_t = 377 \sin(10 \times 10^8 t - 5z) \mathbf{i}_x$  is travelling from a medium characterized by  $\mu = \mu_0$  and characterized by  $\epsilon_0 = 2.25$  to free space. Find  $H_i$ ,  $E_r$ ,  $H_r$ ,  $E_2$ , and  $H_2$ . Derive the formula you use.

OR

Derive suitable relations for integral and point forms of Poynting Theorem. Derive the expression for power flow in a coaxial cable using Poynting vector.