

MASTER OF ELECTRICAL ENGINEERING EXAMINATION, 2025

(1-ST YEAR, 1-ST SEMESTER)

FIELD COMPUTATION OF ELECTROMAGNETIC DEVICES

Time: 3 hours Full Marks: 100

Use separate Answer-script for each part (66 marks for this PART-I)

Answer any three questions. All symbols have their usual significance

PART-I

1. a) What is the **definition of curl**? Derive the **expression for curl** of a vector field **B** using **definition of curl**, written as $\nabla \times \mathbf{B}$ where ∇ is the vector differential operator in Cartesian co-ordinates.

b) Explain $\nabla \times \mathbf{E} = -\partial \mathbf{B} / \partial t$ in terms of Machine design and energy conversion.

c) Derive the **expression for Divergence** of a vector field **C** using definition of Divergence, written as $\nabla \cdot \mathbf{C}$ where ∇ is the vector differential operator in Cartesian coordinates. 8+8+6=22

2. a) Derive the relation $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D} / \partial t$ and also draw all fields **H, J, D** for this equation.

What are displacement current and conduction current?

b) What do you understand by Magnetic Vector Potential?

Develop the following equation explaining each symbol

$$\nabla \times \left(\frac{1}{\mu} \nabla \times \mathbf{A} \right) + \sigma \frac{\partial \mathbf{A}}{\partial t} + \sigma \nabla \phi = 0.$$

11+11=22

3 a) What do you understand by Magnetic Energy and Co-energy.

b) Draw current & flux in figure-1 and derive an expression for flux linkage with the coil by magnetic circuit method of the cylindrical magnetic device shown in fig.1.

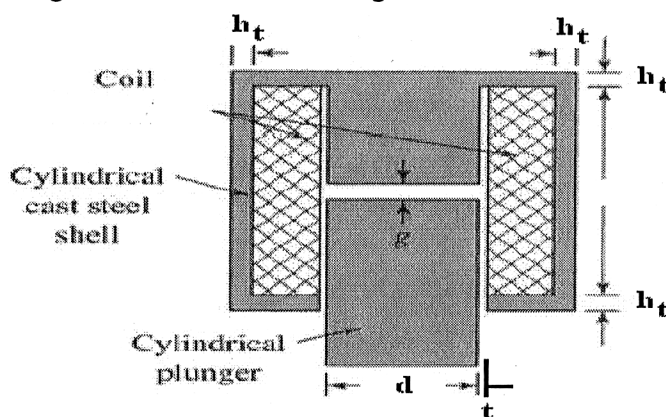


Fig.1

c) Using Finite Element Analysis for E.M.Field computation, derive an expression for flux linkage with the coil of the cylindrical magnetic device shown in fig.1. 5+7+10=22

[Turn over

4 a) Draw current & flux in figure-1 and then considering magnetic circuit & linear operation of the cylindrical magnetic device shown in fig.1 and derive an expression of Magnetic Co-energy in the air-gap and the force when plunger-movement is infinitesimal.

b) Considering linear operation of the cylindrical magnetic device shown in fig.1, derive an expression of Magnetic Coenergy in the air-gap using E.M.Field computation as well as the force when plunger-movement is infinitesimal.

11+11=22

PART – II

[34 marks]

Answer Question No. 1 and any Two from the rest.

- | | | |
|----|--|----|
| 1. | What is Slot leakage flux and Tooth top leakage flux of Armature in a Rotating Machine? Explain. | 4 |
| 2. | With a neat diagram derive an expression for the Specific Permeance of a Tapered slot. | 15 |
| 3. | With a neat diagram derive an expression for the Specific Permeance of a Circular slot. | 15 |
| 4. | Derive an expression for eddy currents in solid rectangular composite magnetic cores. | 15 |