MASTER OF ELECTRICAL ENGINEERING EXAMINATION, 2025

(1-ST YEAR, 1-ST SEMESTER)

FIELD COMPUTATION OF ELECTROMAGNETIC DEVICES(MC)

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) 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

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

11+11=22

2. 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.

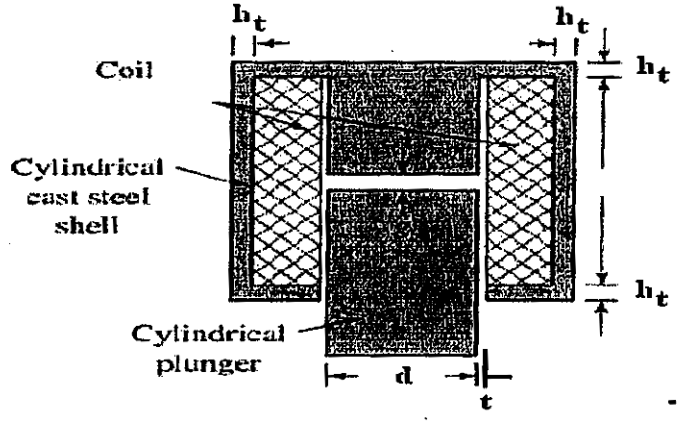

Fig.1

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**

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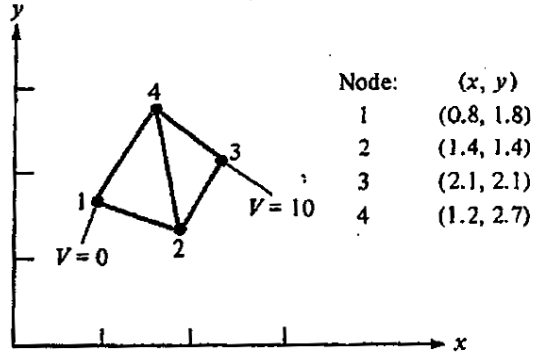
Ref. No.: Ex/PG/EE/T/111A/2025

3 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**

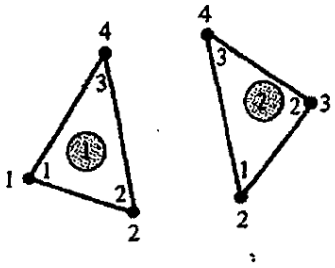
4. a) Consider the operation of an electromagnetic relay shown in Fig.3, where one winding is mounted on a stationary member of iron and a movable member of iron as if attached to a wall of the relay by a spring on one side. Derive the expression for mechanical force if the plunger shown in Fig.3 is allowed to move an infinitesimal distance in the direction of magnetic force acting upon it.

b) Considering a two triangular elements mesh in a x-y plane as shown in fig.2 and using the finite element method, determine the potential within the mesh and in the node 2 and 4. **10+12=22**



Node:	(x, y)
1	(0.8, 1.8)
2	(1.4, 1.4)
3	(2.1, 2.1)
4	(1.2, 2.7)

(a) (a) two-element mesh, (b) local and global numbering of the elements.



(b)

Figure 2

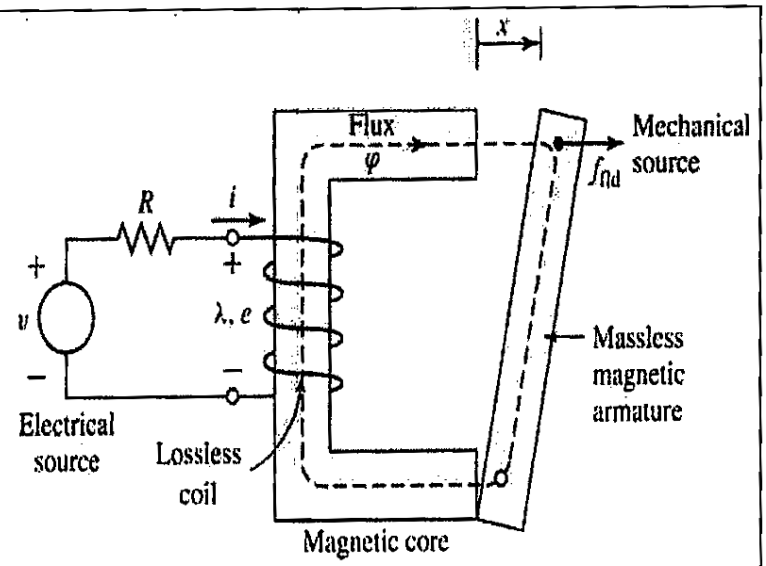


Fig.3

Ref. No.: Ex/PG/EE/T/111A/2025

PART – II

[34 marks]

Answer any Two Questions.

1.	With a neat diagram derive an expression for the Specific Permeance of a Circular slot.	17
2.	With a neat diagram derive an expression for the Specific Permeance of a Tapered slot.	17
3.	Derive an expression for eddy currents in solid rectangular composite magnetic cores.	17