Ref.No. EX/PG/EE/T/111A/[redacted]2018

MASTER OF ELECTRICAL ENGINEERING EXAMINATION, 2018

(1-ST YEAR, 1-ST SEMESTER)

FIELD COMPUTATION OF ELECTROMAGNETIC DEVICES

Time: 3 hours | Full Marks: 100

(64 marks for this part)

Use separate Answer-script for each part

One mark is for neatness. Answer any three questions. All symbols have their usual significance

PART-I

1. a) Explain the importance of the relation $\nabla \times \mathbf{H} = \mathbf{J} + \partial \mathbf{D}/\partial t$ in terms of Machine design and also draw all fields **H,J,D.**
b) Explain $\nabla \times \mathbf{E} = -\partial \mathbf{B}/\partial t$ in terms of Machine design and energy conversion.
c) Explain Gauss's law for magnetic field $\nabla . \mathbf{B} = \mathbf{0}$ in an Electrical Machine. 9+7+5=21

2. a) What do you understand by Magnetic Vector Potential?
b) Develop the following equation explaining each symbol for a time-harmonic magnetic problems:

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

c) Describe Dirichlet's boundary condition, and Neumann's boundary condition. 4+10+7=21

3 a) What do you understand by Magnetic Energy and Coenergy.
b)Derive an expression for flux linkage with the coil by magnetic circuit method of the cylindrical magnetic device shown in fig. 1.

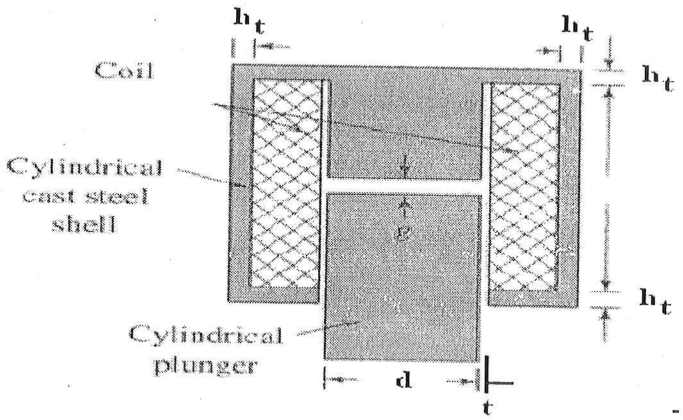


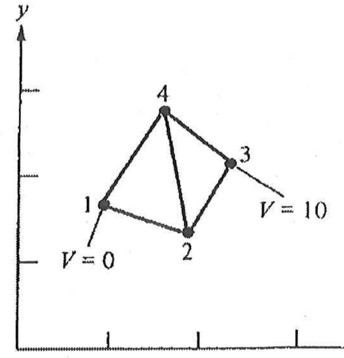
Fig.1

c) Considering linear operation of the cylindrical magnetic device shown in fig. 1,derive an expression of Magnetic Coenergy in the air-gap and the force when plunger-movement is infinitesimal. 4+8+9=21

4 a) 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.
c) Considering linear operation of the cylindrical magnetic device shown in fig. 1,derive an expression of Magnetic Coenergy in the air-gap and apparent inductance as well as the force when plunger-movement is infinitesimal. 10+11=21

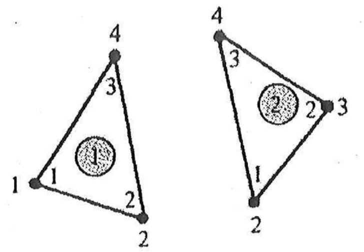
5. a) Considering a typical triangular element and taking a potential function $V_e(x,y)$= a+bx+cy within the element derive the *element shape functions* when potential at the nodes are known as $V_{e1}(x_1,y_1)$, $V_{e2}(x_2,y_2)$ *and* $V_{e3}(x_3,y_3)$.

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 nodes2 and 4.



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**

10+11=21

PART – II

Answer any two questions.

Two marks are for neatness and organized answers.

1. Find the distribution of eddy current in the laminations and the resultant field of a simple solenoid type magnet with M laminations of thickness d. Ignore end field effect. 17

2. Sketch a sectional view of a Parallel Sided Slot used in electrical machines and derive expression for Specific Permeance for Conductor portion and Non-conductor portion. 17

3. With a neat sketch find the Total Specific Permeance of slots with double layer winding frequently used in electrical machines. 17