Ref.No. EE/PE/B/T/421C

BACHELOR OF ELECTRICAL ENGINEERING EXAMINATION,2022

(4-th YEAR, 2nd SEMESTER)

Advanced Electrical Machine Modelling & Analysis

Full Marks:70

(35 marks for each part)

Use separate Answer-script for each part

PART-I

Answer any two questions. one mark is for neatness. All symbols have their usual significance

1. a) Consider the operation of an electromagnetic relay shown in fig.1, where one winding is mounted on a stationary member of iron and a movable member of iron is attached to a wall of the relay by a spring on one side. Now show that the energy converted to mechanical form equals the area between the two magnetization characteristics (flux vs.mmf) respectively for the open position and closed position with respect to movement of the plunger. Assume the necessary parameters for the system concerned.

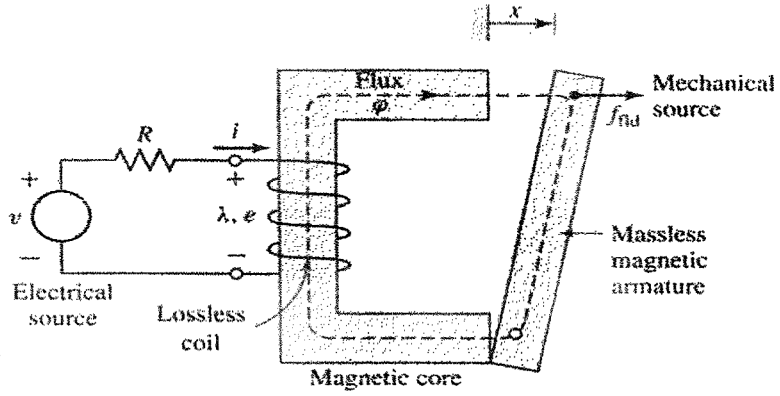

Fig.1

b) Derive the expressions for mechanical force in terms of field energy and co-energy if the plunger shown n fig.1 is allowed to move an infinitesimal distance in the direction of magnetic force acting upon it. **9+8=17**

2. In an electromagnetic relay shown in fig. 1, the exciting winding has 3000 turns. The cross-sectional area of the magnetic core is 30 cm × 30 cm. The reluctance of the magnetic circuit may be assumed to be negligible. Also neglect fringing effects.

i) Draw this figure showing the flux and find the coil inductance for an air-gap of x = 2cm at both ends of the plunger. What is the field energy when the coil carries a current of 10A? What are the forces on the plunger under these conditions?

ii) Find the mechanical energy output when the plunger moves in the direction of magnetic force acting upon it, from

x = 2cm to x = 1cm at both ends of the plunger assuming that the coil current is maintained constant at 10A.

Also find the mechanical energy output if the flux linkage is maintained constant during plunger movement. **17**

[Turn over

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3. Cross section of a cylindrical **solenoid magnet** is shown in fig.2; which shows the cylindrical plunger of mass 'M' kg. moves vertically in brass guide rings of thickness 't' meter and mean diameter 'b' meter . The permeability of brass is the same as that of free space. The plunger is supported by a spring whose elastance is 'K' newtons/m. Its

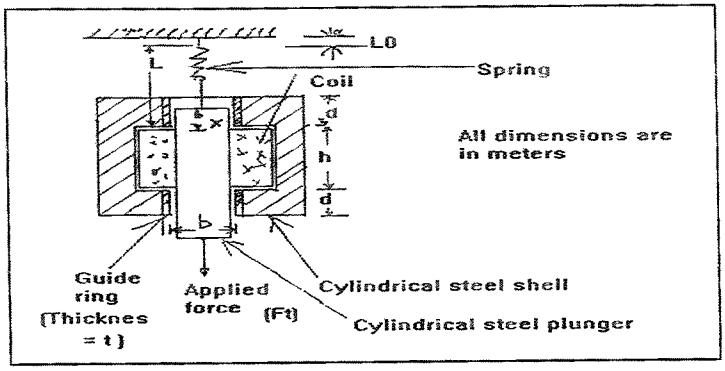

Fig.2

length is 'L_0'. A mechanical load force 'Ft' newtons is applied to the plunger from the mechanical system connected to it. Assume that the frictional force is linearly proportional to velocity and that coefficient of friction is 'p' newtons-sec/m. The coil has 'N' turns and a resistance of 'r' ohms. Its terminal voltage is 'v' volts and its current is 'i' Amps. The effects of magnetic leakage and reluctance of the steel are negligible.

i) Draw this figure showing the flux and derive the **dynamic equations of motion** of the electromechanical system.

ii) Adjust this electromechanical system to have a stable quiescent point. Find the relations among the quiescent values of the terminal voltage, current, applied mechanical force, and displacement in terms of the spring constant 'K', the dimensions of the spring and magnet and the weight of the plunger. Then **linearize** the differential equations for incremental operation around the quiescent point. **9+8=17**

4. a). In an electromagnetic-energy-conversion-device shown in fig.3, if one winding is mounted on a stationary member of iron and another winding is mounted on the movable member of iron then draw this figure showing the flux and obtain the expression for electromagnetic torque in this doubly excited rotational electromechanical energy converter. Assume the necessary parameters for the system concerned. Also derive expressions for the speed and the transformer emfs. **17**

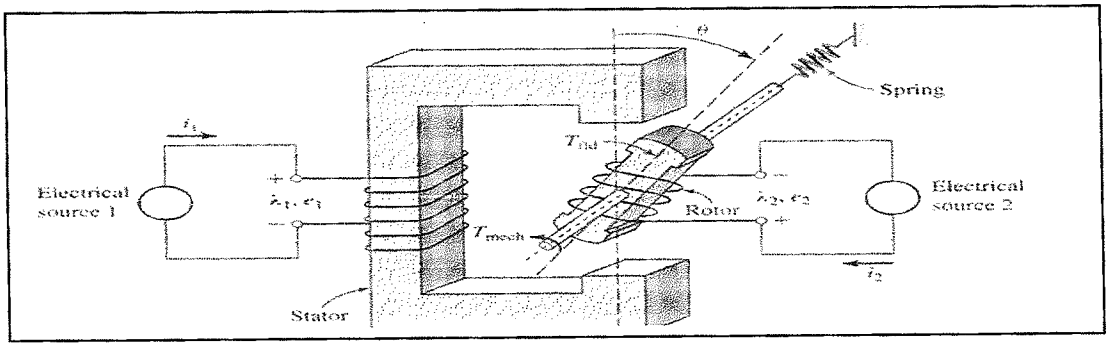

Fig.3

5.

a) Describe field energy and co-energy for an electromechanical system.

b) Explain magnetostriction and its equation.

c) Explain why circular winding is better than other shapes with its equation. **7+5+5=17**

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B.E. ELECTRICAL ENGINEERING EXAMINATION, 2022

(4th Year, 2nd Semester)

ADVANCED ELECTRICAL MACHINE MODELLING & ANALYSIS

Time : Four hours Full Marks : 70

(35 marks for each part)
(Use separate Answer Script for each part)

PART – II

Answer ANY TWO questions.

One mark is for well-organized answers.

6. Draw the (i) basic two-pole machines diagrams and (ii) primitive machine diagrams for the (a) DC Compound machine and (b) Synchronous machine with amortisseurs winding. 17

7. What is Korn's primitive machine (or generalized machine) model of rotating electrical machines? How are the various windings of machine represented by the primitive machine? Write the voltage equations for Korn's primitive machine. 17

8. Obtain the identical transformations for currents and voltages from the rotating balanced 3-phase (a, b, c) winding to a rotating balanced 2-phase (α, β) winding. 17

9. Write notes on (i) Power invariance in transformation and (ii) Physical concept of Park's transformation. 17