BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING EXAMINATION, 2018
(4^{th} Year, 2^{nd} Semester)

ADVANCED ELECTRICAL MACHINE MODELLING AND ANALYSIS

Time : Three hours Full Marks : 100

(50 marks for each part)

(Use separate Answer Script for each part)

PART – I

Answer any Three questions. Two marks are for well organized answer.

1. What do you mean by quasi-holononic reference frame? For a generalized machine having two layers of stator and rotor windings along the quasi-holonomic reference frame develop the impedance matrix. 2+14

2.(a) Develop the voltage equations of a generalized machine in the non-holonomic reference frame. 8

(b) Establish the relation between the torque matrix and inductance matrix of the generalized machine in the rotating reference frame. 8

3. For a compound wound dc motor, derive the expression for impedance matrix. Find the current flowing through its different branches. Also find out the expression for a DC shunt motor. 12 +4

4. For a single phase induction motor derive the expression for impedance matrix and torque matrix and hence develop its equivalent circuit. 16

5. Define bucking impedance of a transformer? How can you determine the bucking impedance between two coils of a three limbed core type transformer having a turns ratio 'n' when (i) the two coils are on the same limb and (ii) the coils are on different limbs? Explain. 2+14

Ref.No. EE/T/422C/2018

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PART-II

Answer any three questions. Two marks for neatness. All symbols have their usual significance

1. Cross section of a cylindrical **solenoid magnet** is shown in fig.1; 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

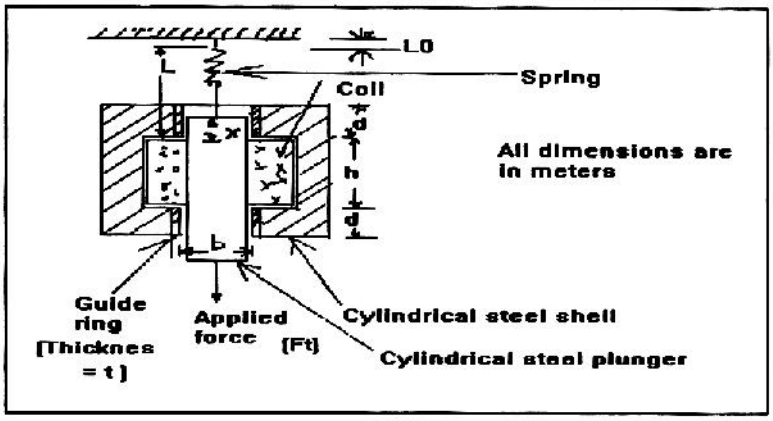


Fig.1

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.

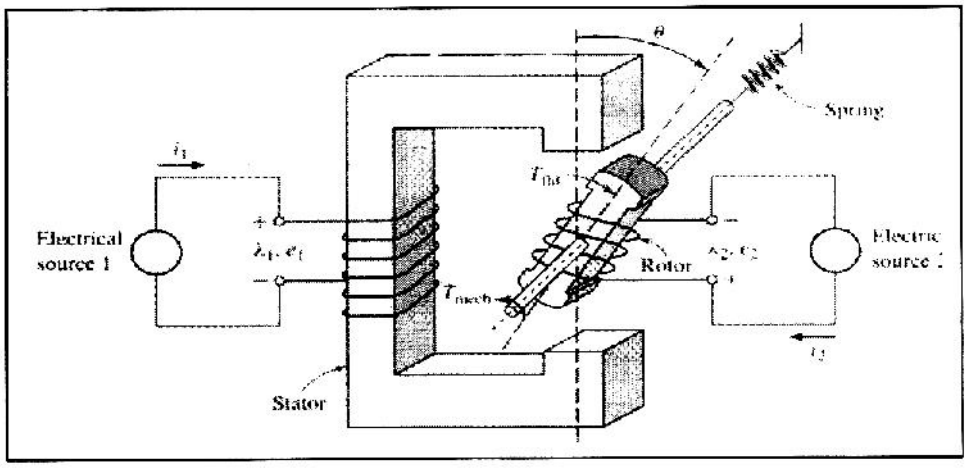
i) Derive the **dynamic equations of motion** of the electromechanical system.

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. 8+8=16

2. For the electromechanical system shown in **fig.1,** considering linearized incremental dynamic equations of motion of the system operating for incremental motion around a quiescent point, develop the **equivalent circuit** where the mechanical variables and parameters are replaced by electrical variables and parameters:-mechanical forces by currents, velocities by voltages, masses by capacitances and spring constants by reciprocal inductances and friction coefficients by conductances.
Also Develop **transfer-functions** and draw and explain the **block diagram** for the equivalent circuit of the above system. 8+8=16

3. In an electromagnetic-energy-conversion-device shown in fig.2, if one winding is mounted on a stationary member of iron and another winding is mounted on the movable member of iron then 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. 10+6=16

Fig.2



4.

a) Describe a Single-phase Electrostatic Synchronous Machine.

b) Why Electromagnetic Machinery is a good choice than Electrostatic one, explain. 8+8=16

5.

a) What are space vectors for flux, voltage and currents ($\overline{\psi_s}$, $\overline{u_s}$ and $\overline{i_s}$) in a **stator** of

3-phase induction motor? For a 3-phase induction motor derive stator vector voltage equation $\overline{u_s} = \overline{i_s}\, R_s + \frac{d\overline{\psi_s}}{dt}$.

b) Derive the transformed **rotor** vector voltage equation of a 3-phase induction motor if the stator voltage equation is $\overline{u_s} = \overline{i_s}\, R_s + \frac{d\overline{\psi_s}}{dt}$ 8+8=16

[Turn over