Bachelor of Electrical Engineering Examination (Old), 2017

(4th Year, 2nd Semester)

ELECTRICAL MACHINES MODELLING AND ANALYSIS

Time: Three Hours **Full Marks:** 100

(50 marks for each part)
Use a separate Answer-Script for each Part

PART - I

Answer ***any three*** questions from this part.
Two marks are reserved for neat and well organised 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. 16

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. Developing the impedance matrix of a compound wound dc motor, derive the expression for current flowing through different branches. Hence find out the expression for armature current for a dc shunt motor. 16

4. Determine the impedance matrix and torque matrix of a single phase induction motor and hence develop the equivalent circuit. 16

5. What do you mean by bucking impedance of a transformer? Describe the methods of determining 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. Discuss the limitation of the method, if any. 16

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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 un-stretched

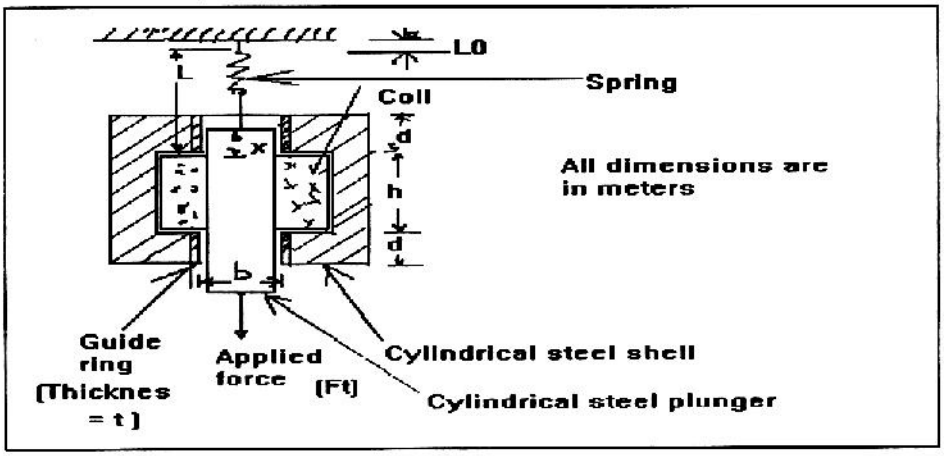

Fig.1

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

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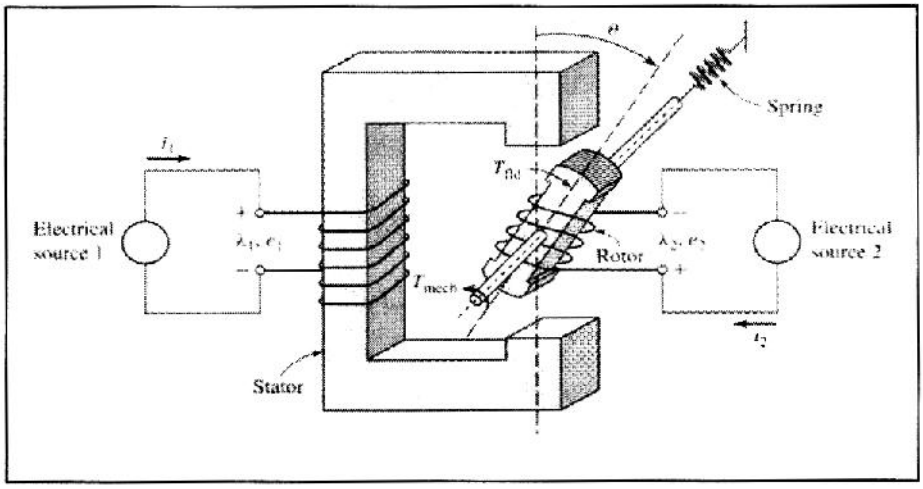
3. In an electromagnetic-energy-conversion-device shown in fig.2, if one winding is mounted on a stationary member of iron and another winding is mounted on the movable member of iron then obtain the expression for electromagnetic torque in this doubly excited rotational electromechanical energy converter. 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 is Electromagnetic Machinery a good choice than Electrostatic one. 8+8=16

5. Write Short Notes 8+8=16

a) Linearization Technique of the differential equations for incremental operation around the quiescent point in a singly excited transducer(EM relay) where the coupling terms expressing the mutual interactions of the electrical and mechanical systems having induced voltage and magnetic force for motion.

b) Quasi-static Electric Field as a coupling medium for an energy conversion device.