Ex/EE/T/422 C/2019

B.E. ELECTRICAL ENGINEERING EXAMINATION, 2019

(4th Year, 2nd Semester)

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ADVANCED ELECTRICAL MACHINE MODELLING & ANALYSIS

(4th Year, 2nd Semester)

ADVANCED ELECTRICAL MACHINE MODELLING & ANALYSIS

(50 marks for each part)

(Use separate Answer Script for each part)

Time : Three hours Full Marks : 100

(50 marks for each part)

(Use separate Answer Script for each part)

Two marks are for well-organized answer.

PART – I

Answer any three questions.

1. Distinguish between the holonomic and non-holonomic reference frames. Develop the voltage equations of a generalized machine in the non-holonomic / holonomic reference frame. 4+12

2. Develop the impedance matrix of a compound wound DC motor and derive the expression for current flowing through different branches. Hence find out the expression for armature current for a DC series motor. 10+6

3. (a) Write the torque matrix and impressed voltage matrix of an induction motor in quasi-holonomic reference frame. 8

   (b) Find out two phase symmetrical components of an induction motor and using this draw the equivalent circuit. 8

4. Develop the impedance matrix of the Capacitor Motor from the generalized machine of the first kind and transform it into the symmetrical sequence axes. Hence draw the equivalent circuit of the motor. 10+6

5. What do you mean by bucking impedance of a transformer? Describe the methods for determining the bucking impedance between two coils of a three limbed core type transformer having a turns ratio 'n' when the two coils are on the same limb. Discuss the limitation(s) of the method, if any. 8+8

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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

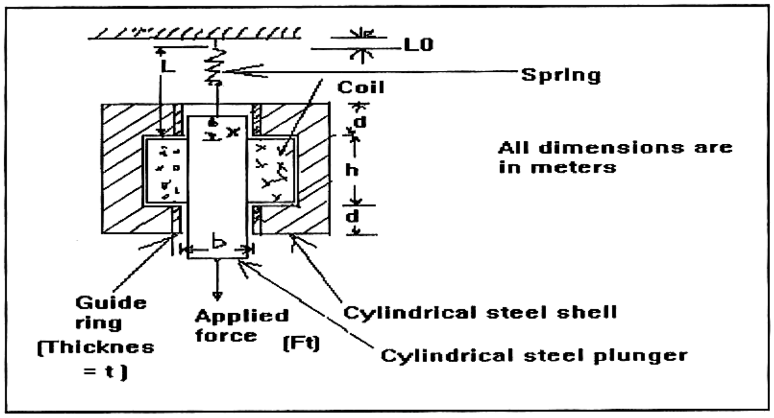

Fig.1

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 'h' 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, mass by capacitance and spring constant by reciprocal inductance and friction coefficient by conductance.
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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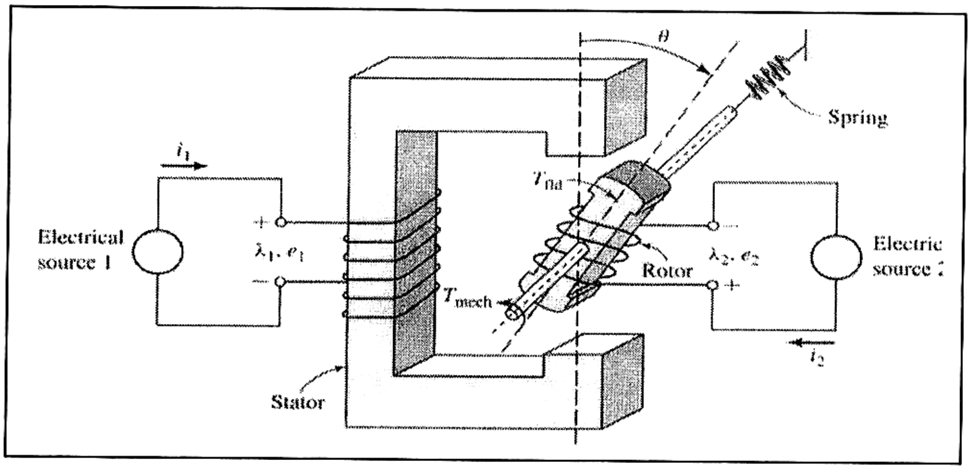
3. In an electromagnetic-energy-conversion-device shown in fig.2, if one winding is mounted on a stationary member of iron and another winding is mounted on the movable member of iron then obtain the expression for electromagnetic torque in this doubly excited rotational electromechanical energy converter. 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 and explain a working Single-phase Electrostatic Synchronous Motor.

b) Why is an Electromagnetic Machinery a good choice than Electrostatic one? 8+8=16

5.

a) What are the 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