I SEMESTER M.TECH (POWER ELECTRONICS AND DRIVES)
END SEMESTER PROCTORED ONLINE EXAMINATIONS
FEBRUARY 2022
MODELLING AND ANALYSIS OF ELECTRICAL MACHINES [ELE 5172]
REVISED CREDIT SYSTEM

Time: 75 Minutes + 10 Minutes **Date: 14 February 2022** **Max. Marks: 20**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Time: 75 minutes for writing + 10 minutes for uploading.

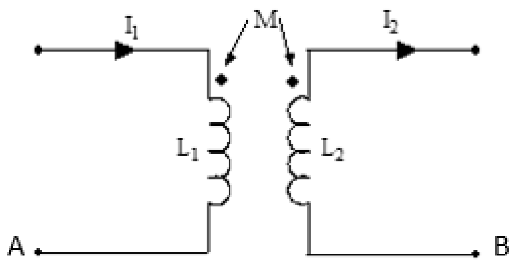
1A. Derive the expression for magnetic field energy in a doubly excited system with total input power of $V_a i_a + V_b i_b$

Assume linear core with self-inductance L_a and L_b for the two systems and mutual inductance of M_{ab}. ***(03)***

1B. Consider a 3 phase 4 pole 50 Hz induction motor with voltage measured across slip rings at a frequency of 1.5Hz. Calculate the speed of the rotor field with reference to (a) rotor speed and (b) synchronously rotating speed at this operating condition.

Also, describe the potential applications of different reference frame approaches in the mathematical modeling of three-phase AC machines. ***(04)***

1C. The coupled coils given in Fig.1 has L_1 = 0.23 H; L_2 = 0.18 H and 75% coupling. Assuming a suitable current flow in the coils find the magnetic field energy if points A and B are connected together.



(03)

2A. Prove the importance of variation in self-inductance with respect to rotor position in a singly excited system. Also, give an example of a rotating machine working under this principle. ***(04)***

2B. Consider the matrix equation (equation-1) relating d and q axes voltages and currents, in an arbitrarily rotating reference frame at a speed of ω_c. The rotor speed is ω_r electrical rad/sec. R_s & R_r are the stator and rotor winding resistance per phase respectively. L_s & L_r are the stator and rotor leakage inductance per phase respectively. L_m is the magnetizing inductance per phase & p is the differential operator with respect to time.

$$\begin{bmatrix} v_{qs}{}^{c} \\ v_{ds}{}^{c} \\ v_{qr}{}^{c} \\ v_{dr}{}^{c} \end{bmatrix} = \begin{bmatrix} R_s+L_s p & \omega_c L_s & L_m p & \omega_c L_m \\ -\omega_c L_s & R_s+L_s p & -\omega_c L_m & L_m p \\ L_m p & (\omega_c-\omega_r)L_m & R_r+L_r p & (\omega_c-\omega_r)L_r \\ -(\omega_c-\omega_r)L_m & L_m p & -(\omega_c-\omega_r)L_r & R_r+L_r p \end{bmatrix} \begin{bmatrix} i_{qs}{}^{c} \\ i_{ds}{}^{c} \\ i_{qr}{}^{c} \\ i_{dr}{}^{c} \end{bmatrix} \text{-----(1)}$$

Starting from equation-1, derive the expression for developed electromagnetic torque in terms of d and q axes currents. ***(04)***

2C. Derive the power equivalence between a three-phase system with input power $v_1 i_1+v_2 i_2+v_3 i_3$ and a two-phase system with input voltages and currents as v_q, v_d, and i_q, i_d respectively.

(02)