ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4405 / EEE 4491
Course Title: Energy Conversion II

Summer Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are 3 **(three)** questions. Answer all 3 **(three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Answer the following questions in brief: **21 (CO1, PO1)**
   - (i) Explain the concept of slip and its impact on the rotor speed and torque of a 3-phase induction motor.
   - (ii) Explain the concept of "Electrical Braking" in a 3-phase induction motor.
   - (iii) The speed of the rotating magnetic field (RMF) referred to as synchronous speed - explain.
   - (iv) Explain the behavior of a 3-phase induction motor for both standstill and running conditions if the slip-ring connection of a wound rotor is kept open and a 3-phase supply is given to the stator.
   - (v) Explain the behavior of a 3-phase squirrel cage induction motor if you give single-phase and neutral supply disconnecting other two phases.
   - (vi) Load increase in a 3-phase induction motor results in increased current consumption - explain.

   b) A 3-phase squirrel cage rotor induction motor is rotating with 1440 rpm. It has 4-pole per phase configuration. Under this running condition, find the current frequency in the stator side and the rotor side? **04 (CO2, PO2)**

2. a) Torque of an induction motor (T_r) can be written as, **14 (CO2, PO2)**

$$T_r = \frac{90}{\pi N_s} \frac{sE'^2_2 R_2}{R_2^2 + (sX'_2)^2},$$

   where, N_s is in rpm.

   - (i) Using above equation, derive the condition of maximum torque under running condition.
   - (ii) Suppose a three phase induction motor is having a total rotor resistance of R_2 and standstill rotor reactance, X_2 where $R_2 > X_2$. Show the effect of increasing rotor resistance on torque speed characteristic curve.
   - (iii) For a fixed load, if you increase the supply voltage of a three phase induction motor, show the changes in synchronous speed and the rotor speed. Show the effect using a typical torque-speed characteristics curve.
   - (iv) Show the effect of changing rotor resistance (R_2) on the rotor current (I_2) for both standstill condition and running condition.

b) A 440-V, 3-phase, 50-Hz, 4-pole, Y-connected induction motor has a speed of 1490 rpm. The rotor has an impedance of (0.4 + j4) ohm and rotor/stator turns ratio of 0.8. **11 (CO2, PO2)**

(i) Calculate the generated torque at 1490 rpm.
(ii) Calculate starting torque.
(iii) Calculate starting current of the rotor.
(iv) Under running condition if the load torque is increased to 78.87 Nm, determine the speed of the rotor.
(v) Sketch the torque speed curve for the mentioned motor.

3. a) Figure 3.a shows the typical magnetic starter circuit diagram for a three phase induction motor. Briefly describe how the starter circuit provides short-circuit protection, overload protection and undervoltage protection for a three phase induction motor. **13 (CO1, PO1)**

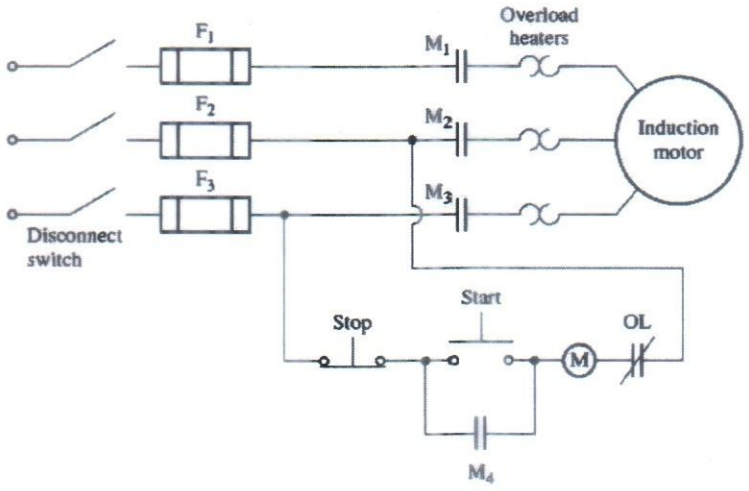

Figure 3.a

b) For the single phase induction motor shown in Figure 3.b, if you provide a single phase ac supply, state the motor's rotation status. Briefly explain using double revolving field theory. **12 (CO1, PO1)**

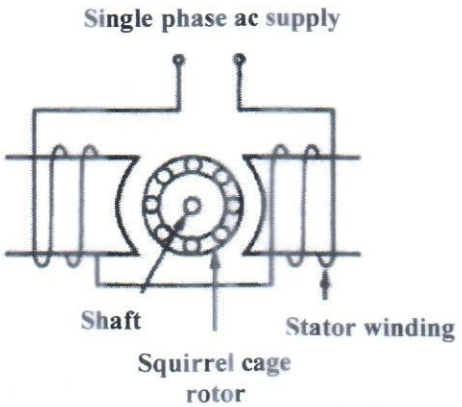

Figure 3.b