(6)

B.Sc. in EEE, 4th Semester
DTE. 2nd Semester

March 05, 2024 **(Afternoon)**

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. 2022-2023
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) i. Find the voltage induced in the different segments of a simple rotating loop placed in a uniform magnetic field. **10 (CO1, PO1)**

   ii. Briefly explain the difference between "full-load" and "over-load" of a motor.

   b) Consider a three-phase induction motor connected to a three-phase power supply. The motor operates under normal conditions without any external mechanical load applied to its shaft. Now, imagine gradually increasing the mechanical load on the motor's shaft while monitoring its operating parameters. **15 (CO1, PO1)**

   i. Describe how the slip of the motor changes as the mechanical load increases from no load to full load. Explain the reason for this change in slip.

   ii. Explain the effect of an increase in mechanical load on the motor's stator current. Provide a brief explanation of the electrical principles that account for this behavior.

   iii. Suppose the motor reaches its full-load condition. If the load is increased further, pushing the motor into an overloaded state, Identify potential risks or consequences for the motor's performance and longevity.

   c) A 208 V, three phase, twelve-pole, 50 Hz induction motor is running at the full-load condition with a slip of 0.03. **10 (CO2, PO2)**

   i. Find the synchronous speed of this motor.

   ii. Find the rotor speed of this motor at the full-load.

   iii. Find the rotor current frequency of this motor at the full-load.

   iv. Find the stator current frequency of this motor at the starting of the motor.

   v. Find the stator current frequency of this motor at the full load.

   vi. Calculate the synchronous speed if the supply frequency is changed to 60 Hz.

   vii. If the direction of the synchronous speed is reversed when the rotor is running at the full load, calculate the value of slip at that instance.

2. Torque of an induction motor (T_r) can be written as, **15 (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. 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.

ii. 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.

iii. Show the effect of changing rotor resistance (R_2) on the rotor current (I_2) for both standstill condition and running condition.

3. a) Write different methods of making single-phase induction motor 'self-starting'. Show the circuit diagram and the vector diagram of winding currents for the methods where auxiliary windings are used. **10 (CO1, PO1)**

b) Describe the method of reversing the direction of rotation of a capacitor start-induction-run motor. **5 (CO1, PO1)**

c) Describe the operating principle of a shaded pole motor. **10 (CO1, PO1)**