

**International Islamic University Chittagong**  
 Department of Electrical and Electronic Engineering  
 B. Sc. Engineering in EEE

**Midterm Examination, Autumn 2023**

Course Code: **EEE 2401**

Course Title: **Electrical Machines II**

Time: 1 hour 30 minutes

Full Marks: 30

(i) Answer all the questions. The figures in the right-hand margin indicate full marks.

(ii) Course Outcomes (COs) and Bloom's Levels are mentioned in additional Columns.

Course Outcomes (COs), Program Outcomes (POs) and Bloom's Levels (BL) of the Questions		PO	BL
CO			
CO1	Understand and mastery of the basic operations of different types of DC, AC motors and special machines.	POa	C2
CO2	Knowledge of machine control and electrical drives and their applications.	POb	C4
CO3	Ability to calculate and design electrical machines.	POc	C5

Bloom's Levels of the Questions						
Letter Symbols	C1	C2	C3	C4	C5	C6
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

- 1) a) i) We know that the torque is proportional to the product of flux per stator pole and rotor current. What would be the relation between the torque and rotor power factor when rotor is assumed as inductive. CO1 C4 2+4
- ii) How does the slip vary with load? Also, derive the equation of Torque under running conditions.
- 1) b) The star connected rotor of an Induction Motor has a standstill impedance of  $(0.4+j4)$  ohm per phase and the rheostat impedance per phase is  $(6+j2)$  ohm. CO3 C5 4
- The motor has an induced emf of 80 V between slip-rings at standstill when connected to its normal supply voltage. Find
- i) Rotor current at standstill with the rheostat is in the circuit.
- ii) When the slip-rings are short-circuited and motor is running with a slip of 4%.

**OR**

- 1) a) i) "The speed or slip at which maximum torque occurs is determined by the rotor resistance but the maximum torque is independent of rotor resistance" – explain it with proper sketch. CO1 C4 4+2
- ii) Briefly explain the effect of change in supply frequency on torque and speed of an induction motor.

- 1) b) A three phase induction motor having a 6 pole, star-connected stator winding runs on 240V, 50 Hz supply. The rotor resistance and standstill reactance are 0.12 ohm and 0.85 ohm per phase. The ratio of stator to rotor turns is 1.8. Full load slip is 4%.  
CO3 C5 4  
Calculate the developed torque at full load, maximum torque, and speed at maximum torque.
- 2) a) i) Derive the equation to calculate the rotor efficiency of an Induction Motor. CO1 C2, C5 4+2  
ii) Show the power stages within an Induction motor using the Block Diagram.
- 2) b) Why direct switching or line starting of a large Induction motor is not recommended? Explain Star-Delta starter method. CO2 C4 4
- 3) a) i) Write down the name of different methods that can be used for controlling the speed of an induction motor. CO2 C1, C4 1+4  
ii) By using the Double Field Revolving theory explain why single-phase Induction motor is not self-starting?
- 3) b) i) Justify the need for a starting winding in the single-phase Induction Motor to make the motor self-starting. Explain the necessity of using a resistance or a capacitor with the starting winding. CO2 C4 4+1  
ii) Draw the equivalent circuit of a single-phase induction motor.