UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2021

Programme Name: B.Tech. Mechtronics **Semester   : VII**
Course Name   : Electrical Machines **Time   : 03 hrs**
Course Code   : EPEG 4011P **Max. Marks: 100**
Nos. of page(s)   : 04

Instructions:
1. **Attempt all the questions (Theory, Numerical, Case study etc.)**
2. **Attempt all questions serially as per Question paper.**
3. **Answer should be neat and clean. Draw a free hand sketch for circuits/tables/schematics wherever required.**
4. **You are expected to be honest about each attempt which you make to progress in life**

SECTION A [20 marks]

S. No.		Marks	CO
Q 1.	**Match the following:** 1. **Single phase Induction motor** (a) **Thermal power plant** 2. **Synchronous Generator** (b) **robot actuators** 3. **Synchronous motor** (c) **majority Industrial load** 4. **Three phase Induction motor** (d) **Ceiling Fan**	4	CO4
Q 2.	**A 110 V, 60 Hz, 4-pole, single phase induction motor is rotating in the clockwise direction at a speed of 1710 rpm. Determine its per unit slip:** (a) **In the direction of rotation** (b) **In the opposite direction**	4	CO1
Q 3.	**Draw the electrical equivalent circuit of cylindrical rotor synchronous generator and clearly specify all the resultant voltages at every stage.**	4	CO4
Q 4.	**The full load current of a 3 phase, 15 kW, 440V, 4-pole, 50 Hz, Y-connected**	4	CO2

	induction motor is 30 A. Its test data are:
	
	     No-load test: 440V, 8A, 1200W;
	     Blocked rotor test: 100V, 21A, 800W;
	
	Calculate the motor efficiency at full load.		

Q5.	**What is an infinite bus? Describe its characteristics?**	**4**	**CO3**
SECTION B [40 marks]		
Q 6.	**Derive an expression for power developed in a cylindrical rotor alternator in terms of power angle and synchronous impedance**	**10**	**CO3**
Q 7.	**A 440V, 3-phase, Δ connected, synchronous motor has synchronous reactance of 36Ω/phase. Its armature winding resistance is negligible. When the motor runs at a speed of 188.5 rad/s, it consumes 9kW and the excitation voltage is 560 V.** **Determine:** **(a) The power factor** **(b) The power angle** **(c) The line-to-line excitation voltage for a +ve phase sequence** **(d) The torque developed by the motor**	**10**	**CO4**
Q8.	**Explain the principle of operation of capacitor-split type, single phase induction motor with necessary diagrams and phasors. Also, specify two real-world applications for this type of motor.**	**10**	**CO2**
Q9.	**A 10kW, 415V, 3 phase, 4-pole, 50 Hz slip-ring induction motor (SRIM) develops rated output at rated voltage and frequency and with its slip rings short circuited. The maximum torque is equal to twice the full load torque, and occurs at a slip of 8% with zero external resistance in the rotor circuit. Stator resistance and rotational losses are neglected.**	**10**	**CO3**

Determine:

(a) Slip and rotor speed at full load

(b) Rotor ohmic-loss at full load

(c) Starting torque at rated voltage and frequency

SECTION-C [40 marks]	

Q 10.

(a) **A 4 MVA, 22 kV, 50 Hz, 4-pole alternator is connected to an infinite bus-bar. It has synchronous reactance of 15 %.**
Determine the synchronizing power and synchronizing torque per mechanical   degree of phase displacement:
(i) At no-load

(ii) At full load with 0.6 p.f. lagging

5+5

(b) **Illustrate the phenomenon of "Hunting" in synchronous motors. Why it is harmful for motor operation?**

6

(c) **Which of the following is not a necessary condition to be fulfilled for synchronizing two alternators?**
(1) Same frequency
(2) Same speed
(3) Same terminal voltage
(4) Same phase sequence

2   **CO4**

(d) **An inverted V-curve of an alternator connected to infinite bus-bar is the variation of:**

(1) Power factor vs field current at constant load
(2) Terminal voltage vs field current at constant load
(3) Armature current vs field current at constant load
(4) Power factor vs armature current at constant load

2

Q11.	a) Describe the key differences in construction of rotors of a 3 phase alternator used in hydroelectric plant and steam plant.	4	
	b) A 20 HP, 3-phase, 50 Hz, 4-pole induction motor has a full load slip of 3%. The friction and windage losses are 500W. Calculate the rotor copper loss.	3	
	c) A purely single-phase induction motor does not have a starting torque, but has a running torque. Why?	3	CO3
	d) A salient pole alternator has X_d= 1 pu and X_q =0.65 pu. Draw phasor diagram of the machine when operating at full load at p.f. of 0.8 lagging. Find the load angle and induced EMF in per unit (pu).	10	