Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Synchronous & Asynchronous Machines (ELEG 2005) **Semester: IV**
Programme: B.Tech Electrical Engg. & PSE
Time: 03 hrs. **Max. Marks: 100**
Instructions: All questions are compulsory.

SECTION A

S. No.		Marks	CO
Q 1	Enumerate the essential differences between a cylindrical rotor and salient pole rotor construction in an alternator.	**4**	**CO1,2**
Q 2	Discuss the use of Synchronous Motor as a Synchronous condenser.	**4**	**CO3,5**
Q 3	A 208-V, 10hp, four pole, 60 Hz, Y-connected induction motor has a full-load slip of 5 percent i. What is the synchronous speed of this motor? ii. What is the rotor speed of this motor at rated load? iii. What is the rotor frequency of this motor at rated load? iv. What is the shaft torque of this motor at rated load?	**4**	**CO4**
Q 4	Define cogging in an Induction Motor. Suggest ways to mitigate it.	**4**	**CO4**
Q 5	"The starting torque of a capacitor – start 1-Φ Induction Motor is better than that of a resistance – start motor". Justify.	**4**	**CO5**

SECTION B

Q 6	A 3-Φ 1500 kVA, star connected, 50Hz, 2300V alternator has a resistance between each pair of terminals as measured by direct current is 0.16Ω. Asume that the effective resistance is 1.5 times the ohmic resistance. A field current of 70A produces a short circuit current equal to full load current of 376A in each line. The same field current produces an emf of 700V on open circuit. Determine: a. Synchronous reactance of the machine and, b. Full load voltage regulation at 0.8 pf lag. (5+5=10) (OR) Draw and explain the phasor diagram of a salient pole alternator supplying a lagging pf load. (10)	**10**	**CO1,2**

Q 7	A 1000kVA, 11000V, 3-Φ star connected synchronous motor has an armature resistance and reactance per phase of 3.5Ω and 40Ω respectively. Determine the induced emf and angular retardation of rotor when fully loaded at a. 0.8 pf lagging b. 0.8 pf leading	**5+5=10**	**CO5**
Q 8	A 3- ϕ delta-connected cage type induction motor when connected directly to 400V, 50Hz supply takes a starting current of 100 A in each stator phase. Determine a. Line current for direct-on-line starting b. Line and phase starting currents for star-delta starting c. Line and phase starting currents for 72% tapping on autotransformer starting	**2+4+4=10**	**CO4**
Q 9	Using double revolving field theory explain why a 1- ϕ induction motor accelerates if the rotor is first turned in a specific direction. Also draw its complete torque-slip characteristics.	**6+4=10**	**CO4,5**
SECTION C			
Q 10.	a. Compare synchronous impedance method and ampere-turn method for determining voltage regulation in an alternator. b. A 3-phase 10kVA, 400V, 50Hz star connected alternator supplies the rated load at 0.8 pf lagging. If armature resistance is 0.5ohm and synchronous reactance is 10ohm per phase, determine i. Torque angle ii. Voltage regulation (8+12=20)	**20**	**CO 1,2**
Q 11.	a. Discuss the factors on which the maximum torque of an induction motor depends. Derive an expression for maximum torque along with the torque slip characteristics to support your answer. b. For a 3-phase induction motor, prove that the ratio of the starting torque to the maximum torque is $\frac{2}{\frac{1}{sm} + \frac{sm}{1}}$ where S_m is the slip under maximum torque . (12+8=20) (or) The power input to the rotor of 440V, 50Hz, 6-pole 3-phase induction motor is 80kW. The rotor emf is observed to make 100 complete alternations per minute. Calculate: i. The slip ii. The rotor speed iii. Mechanical power developed iv. Torque developed v. Rotor copper loss per phase vi. Rotor resistance per phase if rotor the rotor current is 65A. (20)	**20**	**CO 4,5**

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SECTION A

S. No.		Marks	CO
Q 1	Discuss the advantages of a rotating field system in an alternator.	**4**	**CO1,2**
Q 2	Explain synchronous impedance for a 3-Φ synchronous motor.	**4**	**CO2**
Q 3	Discuss the need for starters in an Induction Motor.	**4**	**CO4**
Q 4	Discuss the constructional modifications to be made in a conventional squirrel cage induction motor to overcome the problem of low starting torque.	**4**	**CO2,4**
Q 5	"1-Φ Induction Motors do not have a starting torque". Justify.	**4**	**CO5**

SECTION B

Q 6	Two 3-Φ alternators operate in parallel. The rating of one machine is 200MW and that of other is 400MW. The droop characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming that the governors are operating at 50Hz at no load , determine, a. Load shared by each alternator if total load is 600MW b. System frequency at this load. **(or)** Sketch and explain the open circuit and short circuit characteristics of an alternator. Discuss how voltage regulation can be calculated by the use of their results.	**5+5=10**	**CO3**
Q 7	With the help of suitable phasor diagrams discuss the effect of varying load current and load changes on a synchronous motor.	**10**	**CO4,5**

Q 8	A 480-V, 60 Hz, 50-hp, 3-ϕ induction motor is drawing 60A at 0.85 PF lagging. The stator copper losses are 2 kW, and the rotor copper losses are 700 W. The friction and windage losses are 600 W, the core losses are 1800 W, and the stray losses are negligible. Find the following quantities: a. The air-gap power $P_{AG.}$ b. The power converted P_{conv}. c. The output power P_{out}. d. The efficiency of the motor.	**2.5*4= 10**	**CO2,5**
Q 9	Obtain the equivalent circuit of a 1-Φ Induction Motor with the help of Double Revolving Field theory.	**10**	**CO 4**
	SECTION-C		
Q 10	a. Draw complete phasor diagram for cylindrical rotor synchronous generator for lagging, leading and unity power factor. b. An alternator has a direct axis synchronous reactance of 0.8 per unit and a quadrature axis synchronous reactance of 0.5 per unit. Determine the per unit open circuit voltage for full load at a lagging power factor of 0.8. (10+10=20)	**20**	**CO3,2**
Q 11	a. Prove that a rotating magnetic field of constant amplitude is produced when 3-ϕ balanced winding is excited by 3-phase balanced currents. Draw relevant diagrams. b. Obtain the complete torque-slip and torque-speed characteristics for a 3-phase induction motor. Also depict the effect of varying rotor resistance. (12+8=20) (or) a. Draw complete power flow diagram for a 3-phase induction motor. b. It is desired to install a 3-phase cage induction motor restricting the maximum line current drawn from 400V 3-phase supply to 120A. If the starting current is 6 times full load current, determine the maximum permissible full load kVA of the motor when i. It is directly connected to the mains ii. It is connected through an auto transformer with a tapping of 60% iii. It is designed for use with star-delta starter (8+3*4=20)	**20**	**CO4,5**