Roll No: --------------------------

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: B.Tech Mechatronics **Semester – III**
Subject (Course): Electrical Machines **Max. Marks : 100**
Course Code :PSEG 209 **Duration : 3 Hrs**
No. of page/s:2

Section A **(5*4=20 M.M.)**

1. (CO2) Derive the expressions for the r.m.s. values of the induced voltages in the two windings of a 1-ϕ transformer connected to a sinusoidal supply.
2. (CO5) Discuss the phenomenon of voltage buildup in a DC generator.
3. (CO1) An alternator employs a rotating field structure whereas a dc machine has a stationary field. Justify.
4. (CO4) Explain in brief the phenomenon of Cogging in an Induction motor.
5. (CO3)For each application: lifts; hair dryer; cranes and CD drives, suggest which type of motor should be used.

Section B **(4*10=40 M.M.)**

6. (CO6) When a 100 KVA, 1-ϕ transformer was tested, following results were obtained:
On open circuit power consumed was 1350 W and on short circuit at full-load current the power consumed was 1190 W. Calculate the transformer efficiency on full load and half-load when working at unity power factor.

7. (CO4) A 4-pole 250 V, wave connected dc shunt motor gives 10kW when running at 1000rpm and drawing armature and field currents of 60 A and 1 A respectively. It has 560 conductors and an armature resistance of 0.2Ω. Assuming a drop of 1V per brush, determine:
   a. Total torque
   b. Useful torque
   c. Useful flux per pole
   d. Rotational losses
   e. Efficiency

8. (CO3) 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.

9. (CO 2) Develop the complete phasor diagram for a salient pole synchronous machine operating at a lagging power factor.

Section C **(2*20=40 M.M.)**

10.a.) (CO2) Prove that a rotating magnetic field of constant amplitude is produced when 3-ϕ balanced winding is excited by 3-phase balanced currents. Suggest way to reverse the direction of rotation of the magnetic field.

b.) (CO7) Synchronous motor is a non self-starting motor. Justify.

(12+8=20)

(OR)

10. (CO2,7) Discuss the need of starters in an induction motor.
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

(6+14=20)

11.a.) (CO 1) Discuss why 1-ϕ induction motors do not have a starting torque.

b.) (CO 2) 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. Give atleast two applications of 1-ϕ induction motor.

(8+12=20)

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Section A **(5*4=20 M.M.)**

1. (CO2) Discuss the importance of voltage regulation in association with a 1-ϕ transformer.
2. (CO5) Derive the expression for emf induced in dc generator.
3. (CO1) Give the essential differences between a cylindrical rotor and salient pole rotor construction in an alternator.
4. (CO4) 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?
5. (CO3) For each application given: conveyor, cranes, vacuum cleaner and computer printer. Suggest which type of motor should be used.

Section B **(4*10=40 M.M.)**

6. (CO2) State the condition for maximum efficiency in a transformer.
   A 1- ϕ transformer is rated at 100KVA, 5000/250V. The full load copper losses are 2000W and iron losses are 1200W. Calculate efficiency at
   i. Full load 0.7 power factor lag
   ii. Half load 0.7 power factor lag

7. (CO6) A cage induction motor when started by means of a star-delta starter takes 180% of full load line current and develops 35% full load torque at starting. Calculate the starting torque and current in terms of full load values, if an autotransformer with 75% tapping were employed.

8. (CO7) "A universal motor can operate from dc as well ac supply". Justify. Also give two applications of universal motor.

9. (CO5) A dc shunt generator gives full load output of 30kW at a terminal voltage of 200V. The armature and shunt field resistance are 0.05Ω and 50Ω respectively. The iron and friction losses are 1000W. Calculate
   a. generated emf
   b. total copper losses
   c. efficiency

Section C **(2*20=40 M.M.)**

10. a.) (CO1) Explain the phenomenon of armature reaction when an alternator is delivering a load current of
   i. Purely lagging power factor
   ii. Purely leading power factor

b.) (CO3) A 3-ϕ star connected alternator has an open circuit line voltage of 6599V. The armature resistance and synchronous reactance per phase are 0.6 ohm and 6 ohm. Calculate the terminal voltage, load angle and voltage regulation if load current is 180A for
   i. 0.9 p.f. lag.
   ii. 0.8 p.f. lead

(10+10=20)

(or)

10.a.)(CO1) Discuss the effect of varying excitation on armature current and power factor in a synchronous motor. Draw relevant V-curves.

b.) (CO3) Discuss various methods employed for starting a Synchronous Motor.

(12+8=20)

11.a.) (CO7) Derive the expression for real power in watts for a salient pole synchronous machine with a suitable phasor diagram and necessary assumptions.

b.) (CO6) Discuss briefly the various methods of speed control of 3-ϕ induction motors.

(10+10=20)