KATHMANDU UNIVERSITY
End Semester Examination [C]
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Level : B. E.
Year : III
Time : 2 hrs. 30 mins.

Course : EPEG 302
Semester : I
F. M. : 40

SECTION "B"

Attempt *ANY FIVE* questions. Assume necessary data if required.

1. a. A 20-MVA 12.2-kV 0.8-PF-lagging Y-connected synchronous generator has a negligible armature resistance and a synchronous reactance of 1.1 per unit. The generator is connected in parallel with a 60Hz,12.2kV infinite bus that is capable of supplying or consuming any amount of real or reactive power with no change in frequency or terminal voltage. (i) What is the synchronous reactance of the generator in ohms?(ii) What is the internal generated voltage$E_A$of this generator under rated conditions?(iii) What is the armature current$I_A$in this machine at rated conditions? (iv)Suppose that the generator is initially operating at rated conditions. If the internal generated voltage $E_A$is decreased by 5 percent, what will the new armature current I_A be? [4]
   b. There is always a third harmonic component in a Y-Y connected transformer. Explain how the third harmonics can be removed for Y-Y connection. [2]
   c. Explain the terms Yd1, Yd11, Dy1 and Dy11 with respect to vector groupings of a 3-phase transformer. [2]

2. a. Two generators are connected in parallel to supply load. Generator 1 has a no-load frequency of 61.5 Hz and a slope of 1 MW/ Hz. Generator 2 has a no-load frequency of 61.0 Hz and a slope of 1 MW/Hz. The two generators are supplying a real load totaling 2.5 MW at 0.8 PF lagging. (i) At what frequency is this system operating, and how much power is supplied by each of the two generators? (ii) Suppose an additional 1MW load were attached to this power system. Whatwould the new system frequency be, and how much power would Generator 1 and Generator 2supply now?(iii) With the system in the configuration described in part ii, what will the systemfrequency and generator powers be if the governor set points on Generator 2 are increased by 0.5 Hz? (iv)Draw the house diagrams for all the three cases mentioned above. [4]
   b. Explain the C-2C connection of an induction machine. [2]
   c. There is no net torque at zero speed for a single phase induction motor. Explain. [2]

3. a. A 2300 V 1000 kVA 0.8-PF-lagging 60-Hz two-pole Y-connected synchronous generator has a synchronous reactance of 1.1 Ω. At 60 Hz, its friction and windage losses are 24 kW, and its core losses are 18 kW. Assume that this generator is connected to a hydro-turbine capable of supplying up to 800 kW. Sketch the capability curve for this generator, including the prime-mover power limit.What is the maximum amount of reactive power this generator can produce? [4]
   b. Comment on the torque-speed curve of a three phase induction motor and explain the effect of varying rotor resistance on the torque-speed characteristics of a wound rotor induction motor. [2]
   c. Describe with a suitable diagram how an induction generator can be connected to the grid and explain the role of capacitor banks for the connection. [2]

4. a. A 208-V, two-pole, 60-Hz Y-connected wound-rotor induction motor is rated at 15 hp. Its equivalent circuit components are $R_1 = 0.200$; R2= 0.120; X_M= 15.0; X_1= 0.410; X_2= 0.410; P_{mech}= 250 W P_{misc} = 0; P_{core}= 180 W. For a slip of 0.05, find(i) The line current, (ii) The stator copper losses(iii) The air-gap power(iv) The power converted from electrical to mechanical form(v) The induced torque(vi) The load torque(vii) The overall machine efficiency. [4]

b. Explain the terms full pitch, short pitch, pitch factor and distribution factor with reference to the stator winding of an alternator. [2]

c. Describe the frequency-power and voltage-reactive power characteristics of a synchronous generator. [2]

5. a. A three phase 400 V induction motor gave the following test readings:

No load: 400 V 13A p.f. = 0.25

Short circuit: 110 V 24A p.f. = 0.45

Draw the circle diagram. If the normal rating is 15.85kW, find from the circle diagram, the line current, power factor, efficiency and slip at full load. Also determine the maximum torque and maximum output power from the motor. Assume the rotor copper loss is half the total copper loss. [5]

b. A 208-V Y-connected synchronous motor is drawing 40 A at unity power factor from a 208-V power system. The field current flowing under these conditions is 2.7 A. Its synchronous reactance is 0.8 Ω. Assume a linear open-circuit characteristic. (i) Find the torque angle δ. (ii) How much field current would be required to make the motor operate at 0.8 PF leading? (iii) What is the new torque angle in part (ii)? [3]

6. a. Explain the use of an excitation system of a synchronous generator with a suitable block diagram. Also show how the excitation system is connected to the synchronous generator. [2]

b. With the aid of proper expressions, phasor diagrams and V-curve explain how a synchronous motor can be used for power factor correction. [2]

c. The following test data were taken on a 7.5hp, four-pole, 208V, 60Hz, design class A, Y connected induction motor having a rated current of 28 A.

DC test:	$V_{DC} = 13.6V$	$I_{DC} = 28.0A$		
No-load test:	V_T= 208V	$I_A = 8.12A$	$I_B = 8.2A$	$I_C = 8.18A$
	f = 60Hz	$P_{in} = 420W$		
Locked-rotor test:	$V_T = 25V$	$I_A = 28.1A$	$I_B = 28.0A$	$I_C = 27.6A$
	f = 15Hz	$P_{in} = 920W$		

Draw the per-phase equivalent circuit for this motor. [2]

d. Two transformers are connected in parallel. The load 140 kVA at 0.8 p.f. lagging is to be shared by them. Determine how the load will be shared when transformer 1 has percentage resistance and percentage reactance 1.1% and 4.9% respectively and transformer 2 has percentage reactance 1.7% and 4.1% respectively. [2]