Kafrelsheikh University
Faculty of Engineering
Department: Electrical Power and Machines
Year: 4th (2007) /2020-2021
Subject: Electrical Machines (4)
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Time Allowed: 3hrs
Full Mark: 90 Mark
Final-term Exam: 2nd Term.
No of pages: 2
Code:EPM4116

This Exam measures the LO's [A.1, A.5, B.1, B. 4, C.1, C.2 and C.4]

Answer the Following Questions:

Question One: (25 Mark) [measures the LO's of A.1, B.1, B. 4, C.1, and C.2]

a) ***Derive*** an expression for the pitch factor of a synchronous machine.

[5Mark/A.1, C.1]

b) A 2-pole, three-phase, 50-Hz, Y-connected, synchronous generator has **three** slots per pole per phase. There are 10 conductors per slot. The flux per pole is **61** mWb:

i). ***Determine*** the induced emf in each phase group,

ii). ***Calculate*** the phase and the line voltages, assuming series connection of phase groups. [10Mark/B.1, and C.2]

c) **A** three-phase, 2000 kVA, 11-kV, Y-connected, 50 Hz synchronous generator, has the following open and short circuit characteristics:

Field ampere-turn, AT	0	10000	15000	20000	25000	30000	35000	45000	50000
O.C.Volt /phase (kV)	0	2.83	4.05	5.2	6	6.7	7.0	7.7	7.9
Z.P.F full load/phase(kV)	-	-	0	-		-	-	5.88	-

Determine the voltage regulation at full load and 0.85-power factor lagging, ***using the zero-power factor method***. [10 Mark/B.4, C.2 and C.4]

Question Two: (25 Mark) [measures the LO's of B.4, C.2, and C.4]

a) ***Explain***, with the aid of phasor diagram the effect of increasing the governor's set points on a synchronous generator operating in parallel with an infinite bus.

[6Mark/C.2]

b) ***Draw*** the phasor diagram for a salient-pole synchronous generator when the machine operates with unity power factor, neglecting the armature-winding resistance

[6Mark/C.4]

c) A 50-MVA, 13.8-KV, 50-Hz, three-phase, Y-connected, round rotor synchronous generator has a synchronous reactance of 1.2 Ω/phase, and field winding resistance of 3.5Ω. The armature resistance is negligible. The rotational loss is 5% of the power developed. When the generator delivers the rated load at a lagging power factor of 0.8, the field current is 6A, ***determine***:

i). The power angle
ii). The efficiency and the torque supplied by the prime mover.
iii). The terminal voltage when the field current has been adjusted so that the terminal voltage is 13.8 KV at no load.

[13Mark/B.4, C.2 and C.4]

Question Three: (20 Mark) [measures the LO's of A.1, A.5, B.4, C.2 and C.4]

a) ***Explain*** with the aid of phasor diagram the effect of changing the excitation of a synchronous motor operating at no load on ***power factor correction***. [8Mark/ A.1, B.4 and C.2]

b) Three physically identical synchronous generators are operating in parallel. They are all rated for a full load of 4 MW at 0.8 PF lagging. The no-load frequency of generator A is 61.5 Hz, and its slope s_{p1} is 1MW/0.6 Hz. The no-load frequency of generator B is 61 Hz, and its slope s_{p2} is 1MW/0.65 Hz. The no-load frequency of generator C is 60.5 Hz, and its slope s_{p3} is 1MW/0.7 Hz.

i). If a total load consisting of 10 MW is being supplied by this power system, ***determine*** the system frequency and ***explain*** the power sharing among the three generators.

ii). ***Is*** this power sharing acceptable? ***Why*** or why not?

iii). ***Suggest*** the suitable actions could an operator take to improve the real power sharing among these generators. [12Mark/A.5, C.2, and C.4]

Question Four: (20 Mark) [measures the LO's of A.1, A.5, B.4, C.1 and C.4]

a) ***Derive*** an expression for the developed power in salient-pole rotor synchronous motor. [5Mark/ A.1, C.1]

b) ***Plot*** V- Curves of asynchronous motor. [5Mark/ C.2, and B.4]

c) A 220-V, 60-Hz, three-phase, Y-connected, salient-pole, synchronous motor operates at full load and draws a current of 60 **A** at 0.8 pf lagging. The **d-** and q-axis reactances are 2.0 Ω/phase and 1.1 Ω/phase, respectively. The armature-winding resistance is negligible, and the rotational loss is 5% of the power developed by the motor. ***Determine***:

i). The excitation voltage

ii). The power developed due to the field excitation and that due to saliency of the motor

iii). The total power developed and the maximum power developed by the motor.

iv). The efficiency of the motor

[10Mark/B.4, and C.4]

Best wishes

Committee of corrections and Testers

Dr. Amlak Abaza