Kafrelsheikh University
Faculty of Engineering
Department: Electrical Power and Machines
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Subject: Electrical Machines (4)
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Full Mark: 90 Mark
Final-term Exam: 2nd Term.
No of pages: 2
Code:EPM4116

This Exam measures the ILOs [a.4, a.13, a.14, b.11, b.14, b.15, c.3, and c.16]

Answer the following questions:

Question One: (25 Mark) [measures the ILOs of a.4, a.13, b.11, b.14, and c.16]

a) ***Derive*** an expression for the distribution factor of a synchronous machine. [5 Mark/a4.1]

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). ***Calculate*** the phase and the line voltages.
   ii). ***Illustrate*** the placement of coils of the stator for a phase group. Assume series connection. [12 Mark/ b.11.1, and c.16.3]

c) A three-phase, 1500 kVA, 11-kV, Y-connected, 50 Hz synchronous generator, has the following open and short circuit characteristics:

Field ampere-turn, AT	0	10000	18000	24000	30000	40000	45000	50000
O.C.Volt (L-L), kV	0	4.081	6.966	8.401	9.652	10.658	11.062	11.36
Z.P.F (L-L), kV	-	-	0	-	-	-	8.48	-

Determine the voltage regulation at full load and 0.8-power factor lagging, ***using the zero-power factor method***. [8Mark/a.13.2, b.14.3, and c.16.3]

Question Two: (20 Mark) [measures the ILOs of a.13, a.14, b.11, b.15 and c.16]

a) ***Explain***, with the aid of phasor diagram: [8Mark/a.13.2, b.11 and b.15.1]
   i). Effect of armature reaction on a synchronous generator induced e.m.f when the power factor of the load is leading.
   ii). Effect of lagging power factor on the terminal voltage of an independent synchronous generator for small and large power factor angles.

b) A three-phase, **1000 kW, 3.3-kV,** Y-connected, salient-pole generator. The d-axis and q-axis synchronous reactances are **1.2** Ω/phase and 0.8 Ω/phase, respectively. The armature-winding resistance is negligible. If the generator operates at rated conditions and 0.9-power factor lagging, ***determine*** (i) the armature induced voltage, E_a and (ii) the power developed by the generator. [12Mark/a.14.2, b.11.1, and c.16.3]

Question Three: (25 Mark) [measures the ILOs of a13, a.14, b.14, and c.16]

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***. [7Mark/ a13.2, b.14.2, and c.16.4]

b) ***Derive*** an expression for the torque angle of a synchronous motor at which the developed power is maximum. [8 Mark/ a13.2, b.14.2]

c) A 480-V, 60-Hz, three-phase, Y-connected, salient-pole, synchronous motor operates at full load and draws a current of 50 A at 0.8 pf lagging. The d- and q-axis reactances are 2.7 Ω/phase and 1.7 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/a.14.2 and c.16.3]

Question Four: (20 Mark) [measures the ILOs of a.4, a.14, b.11, c.3, and c.16

a) Three physically identical synchronous generators are operating in parallel. They are all rated for a full load of 5 MW at 0.8 PF lagging. The no-load frequency of generator A is 61.5 Hz, and its slope s_{p1} is 1MW/0.5 Hz. The no-load frequency of generator B is 61 Hz, and its slope s_{p2} is 1MW/0.6 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 13 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.14.2, b.11.1, b.15.2, andc.16.3]

b) A 588 MVA, 22 kV, 50 Hz, 2-pole, 3-pahse, star-connected direct water-cooled, generator has a stator bore of 1.3 meter and a stator core length of 6 meter. If the stator winding has 2 conductors per slot and there are two circuits per phase, ***calculate***:-

i. The number of stator slots
ii. The average flux density in the air gap.

Assume ac=200000 ampere conductor/meter; the winding factor = 0.92.

[8Mark/ b.11.1, and c.3.1]

Best wishes

Committee of corrections and Testers

Dr. Amlak Abaza