Kafrelsheikh University — Final Exam of 2nd semester-2015-2016
Faculty of Engineering — Department of Electrical Engineering
Subject: **Electrical Machine4 (S.M.)** course code: EPM4224 Full Mark: 90 Marks
Year: Fourth Electrical Power (R.2007) Number of pages: 2 Time allowed: 3 hours
Exam Date: 21/5/2016

Attempt to solve all questions

Q1: (15 Marks)

a) Why can't synchronous motor start by itself? State the different methods for starting it? Why are damper windings preferred in some cases?

b) A 208-V, 45 KVA- 0.8 pf lead, 60Hz, Δ- connected , synchronous motor has a per phase synchronous reactance of 2.5 Ω. Its friction and windage losses are 1.5 Kw and the core losses are 1 Kw. The motor is supplying a 15-hp load with initial power factor of 0.8 leading. (*i*)- Sketch the phasor diagram of this motor, and find the values I_a and E_f. (*ii*)- If the shaft load is increased to 30-hp. Sketch the behavior of the phasor diagram in response to this change. (*iii*) Find I_a, E_f and the power factor of the motor after the load change.

Q2: (15 Marks)

a) What is meant by hunting in a synchronous machine and how it is minimized?

b) A 3-phase, Y-connected synchronous generator supplies current of 10 A having phase angle of 20° lagging at 400 V. Find the load angle and the components of armature current I_d and I_q if $X_d = 10\ \Omega$ and $X_q = 6.5\ \Omega$. Assume armature resistance to be negligible.

Q3: (15 Marks)

a) What are the impedances in salient pole machine, how can it be measured in laboratory.

b) A 3-phqse, 2000 kVA, 3300 V, Y-connected, salient pole machine has the following OCC:

O.C.V. kV	2.96	3.6	3.95	4.12	4.22
Ampere Turn	6000	8000	10000	12000	14000

The armature has 12 slots/pole and 4 conductors/slot. The leakage reactance drop is 15 %. Determine the voltage regulation on full load at 0.8 pf lagging and the field AT required. *Assume* $R_a = 0$, Cd = 0.85, Cq = 0.45.

Q4: (15 Marks)

A three-phase, 350 kVA, 3300 V, 60 Hz, 6- pole, Y-connected synchronous machine, with a cylindrical rotor type and all losses can be neglected. Its X_s is 10 Ω.

a) When the machine operates as a generator delivering full-load at rated voltage and with a lagging pf of 0.9, construct the circle diagram and hence determine the excitation voltage and the load angle.

b) With the excitation voltage adjusted to the same value as the terminal voltage, find the pf and efficiency when the machine is running as a generator delivering 80 A at rated voltage.

Q5: (15 Marks)

A 3-phase alternator having a full load rating of 15 MVA at 0.85 pf, 2.2 kV, 50 Hz, 300 r.p.m., has a stator diameter of 1.9 m, core length 0.3 m and 180 slots with 5 conductors per slot. Using the information from this machine, with suitable modifications where required, determine the stator diameter, core length, number of slots and conductors per slots for a 3-phase machine to give 3 MVA at 0.8 pf, 6.6 kV, 50 Hz, 600 r.p.m.

Q6: (15 Marks)

a) What is a synchroscope? Explain how it is used for synchronizing an alternator with an infinite bus.

b) Three alternators, operating in parallel at a bus frequency of 50 Hz, share a load of 140 MW as follows: Alternator 1: 40 MW, Alternator 2: 40 MW, Alternator 3: 60 MW. Each alternator is rated at 100 MW. Their governor settings are so adjusted as to give the following fall in frequency from load at 50 Hz to full-load: Alternator 1: 1.25 Hz, Alternator 2: 1.5 Hz, Alternator 3: 2 Hz. How will the three, alternators share a total load of 250 MW? Also calculate the bus frequency at this load.

With my best wishes
Dr. Entg./Mohamed I. Abd EL_Wanis