Homework 5

EE-306 – Electromechanical Devices - Semester 162

Submission Deadline: 10 May 2017 (in class)

Note: You must submit this cover page along with your solution

Student Name	ID	Sr. #	Section

Total Marks Obtained	/

Problem 1

Consider a Europeon city, it is necessary to supply 300 kW of 60 Hz power. The only power sources available operate at 50 Hz. It is decided to generate the power by means of a motor-generator set consisting of a synchronous motor driving a synchronous generator. Answer the following:

How many poles should each of the two machines have in order to convert 50 Hz power to 60 Hz power?

Problem 2

Consider a 3-phase, 195 MVA, 15 kV, 60 Hz, star-connected synchronous machine. The open circuit ans short circuit tests data are given as follows:

Table 1: Open-Circuit Test

I_f (A)	150	300	450	600	750	900	1200
V_{LL} (kV)	3.75	7.5	11.2	13.6	15	15.8	16.5

Table 2: Short-Circuit Test

I_f (A)	750
I_A (A)	7000

(a) Draw the open-circuit characteristic, the short-circuit characteristic, the air gap line, and the modified air gap line,

(b) Determine the unsaturated and saturated values of the synchronous reactance in ohms,

(c) Find the field current required if the synchronous machine is to deliver 100 MVA at rated voltage, at 0.8 leading power factor.

Problem 3

A 3-phase, 120 MVA, 13.8 kV, 0.8 PF lagging, 60 Hz and Y-connected synchronous generator has synchronous reactance of 1.2 Ω per phase, and its armature resistance is 0.1 Ω per phase.

(a) Determine the voltage regulation,

(b) Determine the voltage and apparanet power rating if this generator is operated at 50 Hz with the same armature and field losses at it had at 60 Hz,

(c) Determine the voltage regulation of this generator at 50 Hz.

Problem 4

A 3-phase, 5 kVA, 208 V, four-pole, 60 Hz, star-connected synchronous machine has negligible stator winding resistance and a synchronous reactance of 8 Ω per phase at rated terminal voltage. This synchronous machine is operated as a synchronous motor from the 3-phase, 208 V, 60 Hz power supply. The field excitation is adjusted so that the power factor is unity when the machine draws 3 kW from the supply.

(a) Find the excitation voltage and the power angle. Draw the phasor diagram for this condition,

(b) If the field excitation is held constant and the shaft load is slowly increased, determine the maximum torque (i.e., pull-out torque) that the motor can deliver.

Problem 5

A 230 V, 50 Hz, two-pole, synchronous motor draws 40 A from the line at unity power factor and full load. Determine the following assuming that the motor is lossless:

(a) Output torque of the motor,

(b) What should be done to change the power factor to 0.85 leading,

(c) Magnitude of the line current if the power factor is adjusted to 0.85 leading.

Problem 6

A 3-phase synchronous motor is installed to provide 300 hp to a new industrial process with the following loads:

Induction motors: 1000 hp; 0.7 average power factor; 0.85 average efficiency, and

Lighting and heating load: 100 kW

If the installed synchronous motor operates at 92% efficiency, determine the following:

(a) The kVA rating of the synchronous motor if the overall factory power factor is to be raised to 0.95,

(b) The power factor of the synchronous motor.

!End of Homework Problems!