ECE 333

Final Exam – Spring 2001 – 2 sheets allowed, 3 hours. Work problems in exam book.

Problem #1   (35 points)

A balanced 3-phase, 208 Volt (line-line) source serves a balanced, 3-phase load. A variable 3-phase capacitor bank is connected across the load in a Delta configuration. Measurements of the source line current for various values of capacitor Vars (3-phase) gives:

Capacitor Vars (3-phase):	0	200	400	600	800	1,000	1,200	1,400
Source line current:	3.75	3.43	3.17	3.00	2.92	2.95	3.07	3.29

(a) Approximately how many Vars (3-phase) does the load consume by itself?

(b) Approximately how many Watts (3-phase) does the load consume?

(c) Do you think your answer of (a) is too high, exactly right, or too low? Explain why.

Problem #2 (35 points)

A 7200/240 Volt single-phase transformer is rated at 50 kVA, and has negligible resistance.

(a) Compute a %Z that will limit the voltage drop (magnitude) to 4% when the load is rated current at 0.8 power factor lag (with respect to the load voltage) when rated voltage is applied to the 7,200 Volt side.

(b) With this %Z, what is the short-circuit current on the 240 Volt side when rated voltage is applied to the 7,200 Volt side?

Problem #3 (30 points)

A balanced, symmetrical, 3-phase, Y-connected, 60 Hz, 6-pole, 230 Volt (line-line) induction motor has negligible stator resistance, negligible stator and rotor leakage reactance. The magnetizing reactance referred to the stator is 40 Ohm per phase.

(a) What is the magnitude of the line current if it delivers a load torque of 13 NM at a speed of 1080 RPM?

(b) What is the power factor of the machine at this load?

(OVER)

Problem #4 (30 points)

Given the following tests of a 3-phase, 60 Hz, 6-pole synchronous machine running at 1200 RPM (neglect armature resistance):

$I_f = 2$ A	V = 120 V (line to neutral)	I (line) = 0.
$I_f = 1$ A	V = 0 V	I (line) = 6 A.

(a) What field current is needed to make the power factor at the terminals be unity when it is running as a generator with V = 120 V (line to neutral) and I (line) = 6A.

(b) What is the minimum field current that can be used to provide a load of 2,100 Watts (3-phase) as a generator?

Problem #5 (35 points)

The approximate dynamic equations for a round-rotor synchronous generator are:

$d\delta/dt = \omega - 377$ $\quad\quad$ $\delta(0) = \pi/6$ Radians

$d\omega/dt = 5 - 10 \sin\delta$ $\quad\quad$ $\omega(0) = 377$ Radians/sec

If the mechanical torque term is suddenly switched from 5 to 9 at t = .01 seconds,

(a) Find δ and ω at t = .03 seconds using Euler's method with a time step of .01 sec.

(b) Will the machine return to a speed of 377 Radians/sec? Show why or why not with detailed calculations (not using Euler's method).

Problem #6 (35 points)

A 240 Volt shunt DC motor with an armature resistance of 4 Ohms is driving a 3-phase, 6 pole, 60 Hz, 208 Volt (line-line) synchronous generator. Before the open-circuited generator is synchronized to the grid, the shunt field rheostat is used to control the speed. When the shunt field resistance plus rheostat is 200 Ohms, the motor turns at 1000 RPM.

(a) What is the value of the DC machine shunt field resistance plus rheostat needed to increase the speed to 1200 RPM before synchronizing the generator? Neglect friction, windage, residual voltage, and use a linear model.

(b) When the generator has been synchronized, what happens when the DC machine shunt field resistance plus rheostat is increased to 275 Ohms? Be as specific as you can in describing exactly what happens – use words and numbers.