ECE 333

Final Exam – Spring 2002 (2-sided class sheet allowed), 3 hours. Work problems in exam book.

Problem #1 (35 points)

A balanced, 3-phase, 4-wire, 208 Volt (line-line), Wye-connected source serves a balanced, 3-phase, 4-wire, Wye-connected lagging power factor load. A variable 3-phase capacitor bank is connected across the load in a Delta configuration. Measurements of the source line current for two values of capacitor Vars (3-phase) are:

For capacitor Vars (3-phase) = 0, the source line current = 4.0 Amps
For capacitor Vars (3-phase) = 600, the source line current = 3.0 Amps

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

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

(c) What would the source line current be if the capacitors produced 1,200 Vars?

Problem #2 (35 points)

A 7200/240 Volt single-phase transformer is rated at 50 kVA, and has negligible resistance (and you may neglect all shunt parameters).

Compute the smallest %Z possible that will limit the voltage drop (magnitude) to not more than 2% when the load current is rated at unity power factor and rated voltage is applied to the 7,200 Volt side, AND, WILL ALSO limit the short-circuit current (with rated voltage on the 7,200 Volt side) to not more than 20 times rated.

Problem #3 (30 points)

A balanced, symmetrical, 2 HP, 3-phase, Y-connected, 60 Hz, 6-pole, 208 Volt (line-line) induction motor has a no-load line current of 3 Amps and a full-load line current of 5 Amps. The full-load speed is 1080 RPM.

(a) What is the frequency of the rotor currents at full load?

(b) Find two estimates of the rotor resistance referred to the stator.

(OVER)

Problem #4 (35 points)

A 3-phase, 6-pole, 60 Hz, synchronous generator has an open-circuit voltage of 120 Volts (line-neutral) with 3.0 Amps of field current. If this generator is synchronized to a 120 Volt (line-neutral), 60 Hz source and the field current is reduced to 1 Amp, the line current is 5 Amps at no load (P=0).

If the machine is operated as a motor at this field current (1 Amp), what is the maximum possible load (3-phase Watts) that can suddenly be applied to the shaft?

Problem #5 (35 points)

A 28 V shunt DC motor with R_a = 1.0 Ohm and R_{SH} = 100 Ohm, K_f^{SH} = 1.2 Ohm-Seconds/Radian. Neglect residual voltage and saturation.

(a) What is the no-load speed at rated voltage?

(b) How much resistance should be added to the shunt field to bring the no-load speed to 100 Radians/Sec?

(c) Using the shunt field resistance from (b), what is the speed when the machine is loaded with a shaft torque of 3 NM?

Problem #6 (30 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.