ECE 431

Second Exam - Spring 2006 - Closed book, closed notes (class sheet is attached), 55 min.

Problem points (out of 100) are indicated. Work all problems in exam booklets.

Problem #1 (25 points)

Given the following tests of a 3-phase, 60 Hz, 4-pole synchronous machine running at 1800 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 #2 (25 points)

A 3-phase, 4-pole, 60 Hz, synchronous motor draws zero line current when connected to a source voltage of 120 Volts (line-neutral) with 3.0 Amps of field current.

If the field current is reduced to 2 Amps, the line current is 5 Amps at no load (P=0). With this amount of field current, (2 Amp), what is the maximum possible load (3-phase Watts) that can suddenly be applied to the shaft without losing stability?

(OVER)

Problem #3 (25 points)

Given: A self-excited shunt DC generator is being driven by a gasoline engine at 1100 RPM. At this speed, its internal voltage may be approximated by:

$$E_a = 14 + 180\ I_{sh}$$

The armature resistance is 4 Ohms.

Find:

(a) If the generator is unloaded and the terminal voltage is 240 V at this speed, what is the value of the total shunt field resistance?

(b) What should the total shunt field resistance be if you want to keep the terminal voltage at 240 V when it is loaded to 6,000 Watts and the speed drops to 1050 RPM?

Problem #4 (25 points)

For each of the following changes in operating condition for a dc shunt (might be self or separately excited) motor, describe how the armature current and speed will vary.

(a) Doubling the field current while the armature terminal voltage and load torque remain constant.

(b) Halving the armature terminal voltage while the field current and load torque remain constant.

(c) Halving the armature terminal voltage while the field current remains constant and the load torque varies as the square of the speed.

(d) Halving the armature terminal voltage while the field current and load power remain constant.

(e) Halving both the field current and armature terminal voltage while the load power remains constant.