

ECE 333

Second Exam - Spring 2002 - 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 (40 points)

Given: A balanced, symmetrical, round-rotor, 3-phase, 208 V (line to line), 60 HZ, 2-pole, Y-connected, 8 HP synchronous machine has the following model parameters:

$$R_s = 0, X_s = 10 \text{ Ohms}, \quad K_f \omega_s = 87 \text{ Ohms}$$

It has an armature current rating of 20 Amps.

Find: If the machine is connected to a source with 120 V (line to neutral) and is supplying 4,000 Watts (3-phase) to the source, plot the following 3 points on the "Vee" curve for constant 4,000 Watts (3-phase) power (compute I_a and I_f for each). Hint: $\sin^2 X + \cos^2 X = 1$

- a) Minimum field current
 - b) Minimum armature current
 - c) Rated armature current
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Problem #2 (30 points)

Given: A 208 Volt (line to line) Y-connected, 4-pole, 60Hz synchronous motor is drawing 50 Amps at unity power factor from a 208 Volt (line to line) power system. The field current flowing under these conditions is 2.7 Amps. Its synchronous reactance is 0.8 Ohms. Assume a linear open-circuit characteristic.

- Find:**
- (a) Find the torque angle for this condition.
 - (b) How much field current would be required to make the motor operate at 0.8 power factor leading (Same real power)?
 - (c) What is the new torque angle in part (b)?

(OVER)

Problem #3 (30 points)

Given: A 230 V shunt DC motor has a no-load speed of 1300 RPM. At this speed, its internal voltage may be approximated by:

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

The armature resistance is 4 Ohms. Your starting box is broken.

- Find:**
- (a) What value of resistance should be added in series with your 230 Volt supply to limit the terminal current to 10 Amps during startup?
 - (b) What speed will the motor reach with your starting resistance in the terminal circuit if the machine is unloaded?