FINAL EXAM SPRING 1996

1. Closed book, closed notes, official class sheet allowed
2. 3 hours - work problems in exam booklets.

Problem #1
40 points

A 230 volt (l-l), 3φ, 3 wire source is supplying an induction motor. A wattmeter is connected with the voltage sensing $\bar{V}_{AB}$ and the current sensing $\bar{I}_A$ (into the motor). It reads 1320 W. When B and C of the source wires are reversed, it reads 575 W. What are:

(a) The phase sequence of the original supply?
(b) The line current magnitude?
(c) The power factor of the motor?

Problem #2
20 points

The open and short circuit tests on a single-phase, 7200/120 volt, 10 KVA transformer are:

O.C. $V_2 = 120v$, $I_1 = 0$, $I_2 = 0.5A$, $P_2 = 30w$
S.C. $V_1 = 345V$, $V_2 = 0$, $I_1 = 1.39A$, $P_1 = 80w$

(a) What would you say the nameplate %Z is equal to?

(b) What is the short-circuit current on the low-voltage side when rated voltage is applied to the high-voltage side?

Problem #3
30 points

A 208 volt (l-l), 3ϕ, 4 pole, 60 Hz induction motor has $r_1 = 1\Omega$, $x_1 = 1\Omega$, $x_2' = 1\Omega$, $r_2' = 0.7\ \Omega$.

(a) What is the starting torque at full voltage?
(b) What is the maximum torque at full voltage?

Problem #4
30 points

A 230 volt (l-l), 3ϕ, 6 pole, 60 Hz synchronous machine is connected to an infinite bus at rated voltage and frequency. When the field current is 2.8 Amps, the line current is zero. When the machine is loaded as a generator with 2,400 W (3ϕ), it takes 3.2 Amps of field current to obtain unity power factor. What is the synchronous reactance X_s? (neglect r_a)

Problem #5
30 points

A 240 volt shunt dc motor is driving a 6 pole, 60Hz, 3ϕ, synchronous generator. When 240 volts is applied directly to the 124Ω field winding (and armature), the dc motor turns at 830 RPM. What value of field resistance should be added to the dc machine so that the synchronous machine will produce 60 Hz? (neglect armature resistance)

Problem #6
35 points

A synchronous motor has the following simplified dynamic model:

$$\frac{d\delta}{dt} = \omega - 377$$

$$\frac{d\omega}{dt} = k + 20\sin(-\delta)$$

If the machine is initially in equilibrium with $k = -10$, what will happen if k is suddenly changed to -17? Answer this question two ways:

(a) use Euler's method with a step size of .01 to find $\delta(.03)$ and $\omega(.03)$, and use $k(0) = -10$, $k(.01) = -17$.

(b) use equal area criteria to see if the machine will return to synchronous speed.

Problem #7
15 points

Explain in words and equations why variable speed drives usually enforce constant V/f where V is voltage and f is frequency. When is this not necessary?