EE 30372, Spring 2006
Final Exam
10-11 May, 2005

Show all your work and your answers clearly on the test pages. In any plots and sketches, label and include units (if possible) on anything that might be of interest. You are each allowed one two-sided 8.5 by 11 inch page of formulae for reference. Calculators may be used only for simple trigonometric and (complex variable) arithmetic operations. For full credit, simplify your answers as much as possible.

Problem 1 (40) _____

Problem 2 (20) _____

Problem 3 (35) _____

Problem 4 (20) _____

Total (115) _____

Name_____

1. Short answers (5 pts. each):
   (a) A shunt-wound DC motor with armature resistance of 1Ω and field resistance of 3Ω runs at 1500 rpm clockwise with 75V applied to its terminals. What is its rotation when the voltage is reversed to -75V?

   (b) Write the transform matrix we would need to represent three-phase voltages V_A, V_B and V_C as a function of the symmetric components V_{C0}, V_{C1} and V_{C2}

   (c) Sketch a circuit containing a 5Ω resistor, an inductor and a 25 micro-farad capacitor which will have power factor of 1.0 when connected to a 60 Hz source. All elements must carry current. Specify the inductor's size.

(d) A three-phase, Δ-connected generator has internal impedance of $2.0\angle 60^o$ and internal generated voltage of 480V. The generator suffers a spectacular triple line-to-ground fault; what are the fault currents in the A, B, C leads?

(e) You have a "black box" power system with four ports, and unknown interconnections inside. Your goal is to find the system impedance matrix by using an adjustable current source and a voltmeter. Imagine that you must pay a fee of $\$1$ each time you measure a voltage. What is the minimum you can spend to find all the entries in the matrix? Give brief justification for your answer.

(f) If a single-phase load is consuming 15 kWatts at 240V AC and has power factor 0.7, what is the rms current flowing to the load?

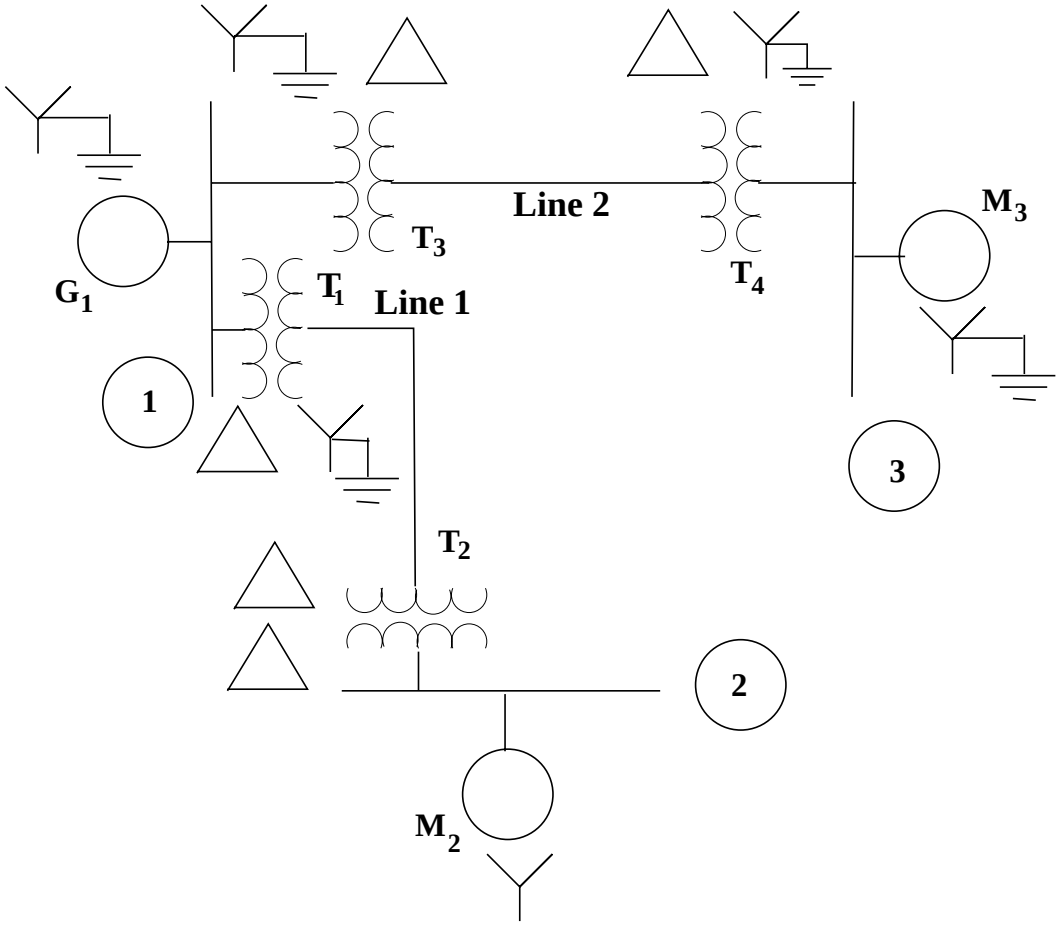
(g) A particular region of a three-phase power system has $S_{base} = 10MVA$, $V_{base}(line - line) = 4160V$. One-line analysis in pu has a generator in the region supplying real power of 0.2 pu. How many Watts of real power is the three-phase generator supplying?

(h) You find that a 100 Watt, 120V bulb is just right for your room when connected to a 120V outlet. What wattage of 120V bulb should you use to get the same amount of light when connected to a 240V source? (Don't worry here about just how long the bulb would last at 240V.)

2. (20 pts.) A permanent magnet DC motor with armature resistance R_A of 2Ω runs at 1000rpm under load with input terminal voltage of 100 V, drawing current of 10 A. Suppose induced torque does not change, but the input voltage is reduced to 50V. What will the motor's rotational speed be?

3. The components of the power system below have the following ratings:

Generator 1(G_1):	100 MVA, 12.4 kV, X_1=0.2 pu, X_2=0.2 pu, X_{g0}=0.2pu
Motor 2(M_2):	100 MVA, 13.8 kV, X_1=0.1 pu, X_2=0.1 pu, X_{g0}=0.1pu
Motor 3 (M_3):	100 MVA, 13.8 kV, X_1=0.05 pu, X_2=0.1 pu, X_{g0}=0.1pu
All $Y-\Delta$ transformers:	100 MVA, 13.8/138 kV, X_1 = 0.05 pu,X_2=0.1 pu, X_0 = 0.05 pu
All $\Delta-\Delta$ transformers:	100 MVA, 13.8/138 kV,X_1 = 0.1 pu,X_2=0.1 pu, X_0 = 0.05 pu
Line 1:	X = 15Ω
Line 2:	X = 30Ω



(a)(20 pts.) Find the first rows of the bus admittance matrices for the positive and zero-sequence components in this system, in pu with S_{base} of 100 MVA and V_{base} of 12.4kV at bus 1.

(b)(15 pts.) A single line-to-ground (phase A) fault occurs at bus 2. Assuming all bus voltages were at $1\angle 0^o$ before the fault, find the fault currents flowing at this bus, and the voltages of all three phases at bus 2 after the fault.

4. (20 pts.) Suppose we have the following bus impedance matrix for a 3-phase power system. A generator maintaining 1 volt at its output terminals is applied to bus 3; no other sources are connected. Find the voltages at the other two buses. (You may assume that the internal impedance of the generator does not affect the impedance matrix.

$$\mathbf{Z}_{bus} = \begin{pmatrix} j0.2 & 0 & j0.1 \\ 0 & j0.3 & j0.2 \\ j0.1 & j0.2 & j0.3 \end{pmatrix}$$