EE 372, Spring 2003
Final Exam
7 May, 2003

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 (25) ______

Problem 2 (20) ______

Problem 3 (35) ______

Problem 4 (25) ______

Problem 5 (15) ______

Total (120) ______

Name______________________________

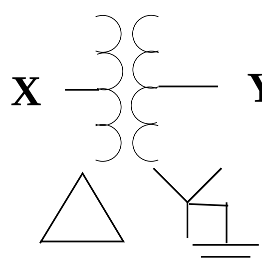
1. Short answers (5 pts. each):
   (a) As we move the parallel-strung wires of a three phase transmission line away from each other, how do the line's shunt capacitance and series reactive impedance vary; that is, which grows and which decreases?

   (b) We find that the symmetric components at a bus are $V_{A0} = 0$, $V_{A1} = 0.8$, $V_{A2} = 0$. What are V_A, V_B and V_C?

   (c) A single-phase load is consuming 10 kW at PF 0.8 lagging. Voltage to the load is 220V at phase angle zero degrees. What is the current into the load?

(d) Two transformers in the same system have the following parameters:
T_1: R = 0.02pu, X = 0.1pu, 13.8/135kV, 20MVA
T_2: R = 0.01pu, X = 0.15pu, 135/13.8kV, 40MVA.
Convert the parameters of T_1 to pu using S_{base} of 40 MVA.

(e) Draw the equivalent circuit, with purely inductive impedance, for the zero-sequence symmetric component at this transformer.



2. Behind your house, you might see something like the wires and transformer sketched below. In answering all the following questions, assume this is standard distribution-level power at 12.4 kV. Recall that the transformer produces single-phase 230V at the secondary. Most importantly, make sure your answers are consistent with each other.

(a) (5 pts) You're perched barefoot atop your 32 foot aluminum extension ladder, trying to get a closer look. The ladder is struck by your neighbor on a riding lawnmower and begins to fall. Your feet remain tangled in the ladder; what wire do you grab to save yourself and why do you choose it? (Assume that you don't want to die.)

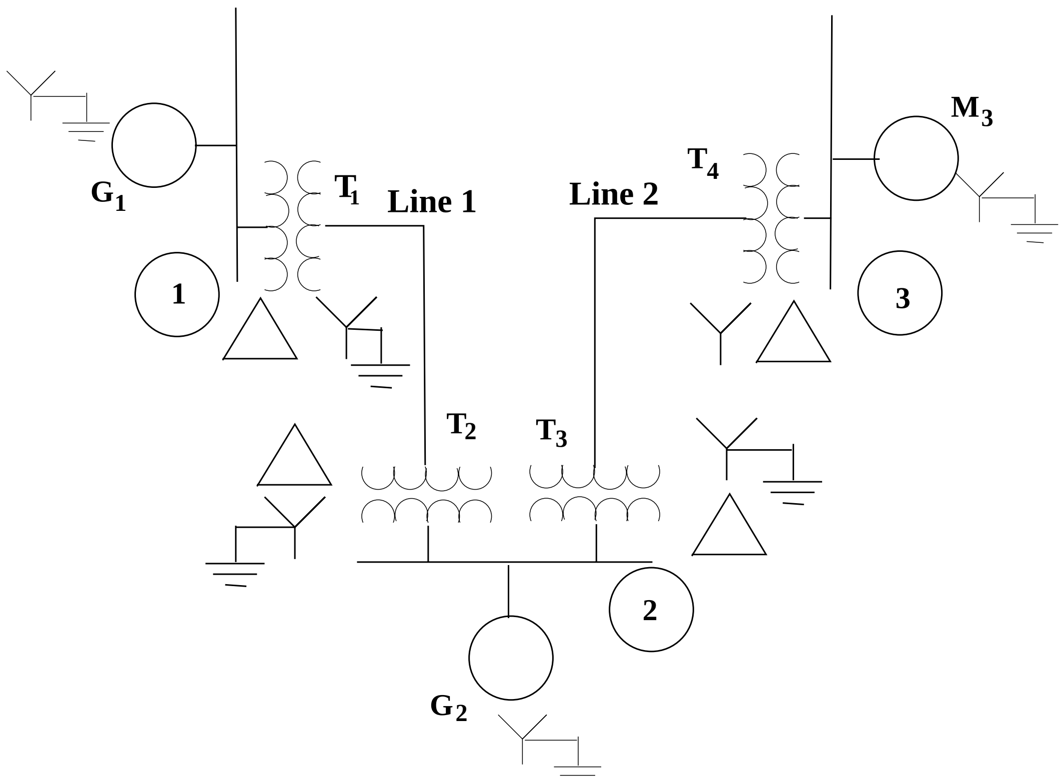
(b) (5 pts.) To which lines would you connect your 115V AC radio, assuming you want it to work properly; why?

(c) (5 pts.) Diagram electrically(using the text's standard symbols and graphics) the transformer and all its connections, assuming the transformer is ideal. Label voltages with numeric values.

(d) (5 pts.) What is V_{DB}?

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

Generator 1(G_1):	100 MVA, 13.8 kV, X_1=0.1 pu, X_2=0.1 pu, X_{g0}=0.1pu
Generator 2(G_2):	100 MVA, 13.8 kV, X_1=0.2 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 $Y-Y$ 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 = 20Ω
Line 2:	X = 30Ω



(a)(10 pts.) Find the matrix $\mathbf{Y}_{bus}$ for power flow computations.

(b)(10 pts.) Find the system's $\mathbf{Y}_{bus1}$ appropriate for the positive sequence component in fault analysis.

(c) (15 pts.) Suppose we have the following bus impedance matrices for the system (these are NOT correct for the parameters given at the beginning of the problem):

$$Z_{bus0} = \begin{pmatrix} j0.3 & 0 & j0.1 \\ 0 & j0.3 & j0.1 \\ j0.1 & j0.1 & j0.3 \end{pmatrix} Z_{bus1} = \begin{pmatrix} j0.3 & j0.1 & j0.1 \\ j0.1 & j0.2 & j0.2 \\ j0.1 & j0.2 & j0.3 \end{pmatrix} Z_{bus2} = \begin{pmatrix} j0.2 & j0.05 & j0.1 \\ j0.05 & j0.1 & j0.1 \\ j0.1 & j0.1 & j0.3 \end{pmatrix}$$

The system is initially stable with all bus voltages (V_A) approximately equal to 1 Volt pu, zero degrees phase. A single line-to-ground fault then occurs at bus 2 on line A. Find the voltages of the three phases at bus 1 during the fault.

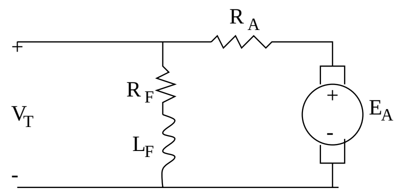
4. A 60 Hz single phase of a medium-length transmission line has total admittance of 3×10^{-4} Siemens, total resistance of 5 Ω and total reactive impedance of 20Ω.

(a) (10 pts.) What is the "charging" current into the line at 10 kV when the receiving end is open? Find also the receiving voltage V_R under these conditions.

(b) (5 pts.) Compute the line's series impedance and shunt admittance if the system is switched to 50 Hz.

(c) (10 pts.) Ignoring the admittance, with a purely resistive load receiving 1 megawatt of power at 10kV, 60 Hz, find the source-side voltage and sketch the complete phasor diagram for the line, including numeric values.

5. The figure below represents a shunt-wound DC motor with $V_T = 200V$, $R_A = 0.2\Omega$, $R_F = 300\Omega$ and magnetization curve as shown on the following page.



(a) (10 pts.) Our voltmeter reads $E_A = 180V$ at the terminals of the motor. Find the speed of the motor and its converted power, P_{conv}.

(b) (5 pts.) Suppose mechanical and stray loss total 1200W, with conditions as given in (a). What torque is being delivered to the shaft of the motor?