Print Your Name____

University of Alabama, Huntsville
Department of Electrical and Computer Engineering

EE 313: Electrical Circuits II
Final Examination
Professor Jennifer English
Spring Semester 2003

This exam is closed book and closed notes. Three 3"X5" pieces of paper with handwritten notes on both sides are permitted. Calculators are also permitted to perform mathematical operations and matrix operations, but no other programmable feature is to be used. The exam consists of 7 questions/problems. The point values for each question/problem are given. The problems are not necessarily equally difficult, so you are encouraged to **read the entire examination before starting** and begin with the problem you find the easiest. The examination is worth a total of 200 points. Partial credit will be given for each problem; however, work must be **legible and logical** to receive credit. **Remember to give applicable units with each answer.** Please place a box around your final answer for each problem.

Please do all your work on this examination paper. If more room is required or you wish to do scratch work, please use the reverse side of a sheet. Remember, partial credit cannot be given if you do your work on a piece of paper you don't hand in!

Please place your name on the top of each examination page.

In the interest of academic honesty, please read the following statement and write your signature below.

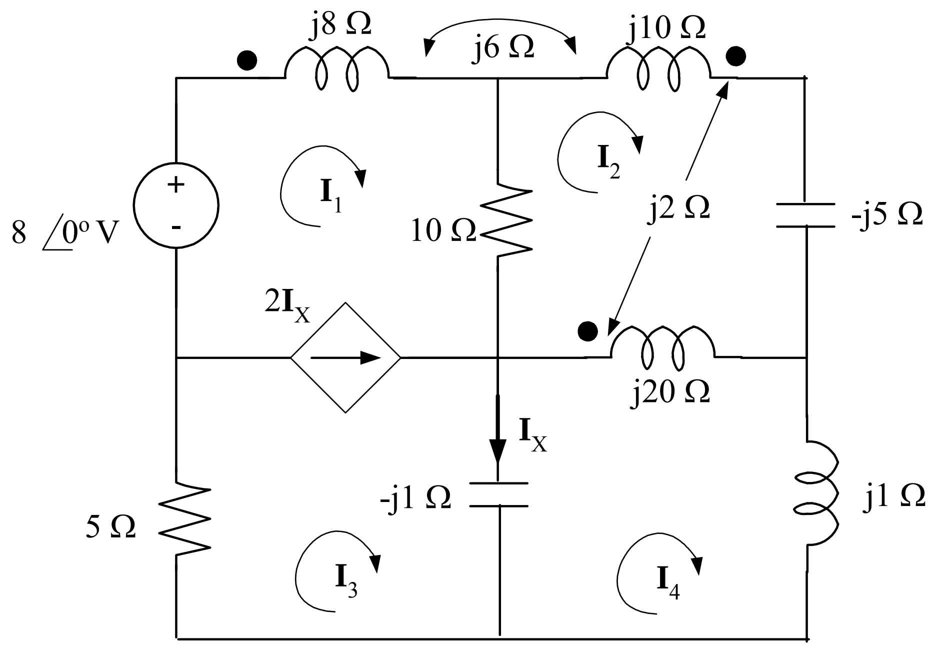
On my honor, I have neither given help to anyone on this examination, nor received help from anyone on this examination.

Signed____________________________________

Name_____________________________________

1. Mutual Inductance **[20 points]**

Consider the following circuit:



[20 points] Using the labeled mesh currents and directions, write down the four mesh equations (Do not simplify). Then write down any other equations required to solve the circuit (i.e. the number of equations equals the number of unknowns). Do not solve the equations.

Name_______________________________________

1. continued

2. Power Factor Analysis [10 points]

You are given two loads in parallel that are connected to a single phase voltage source:

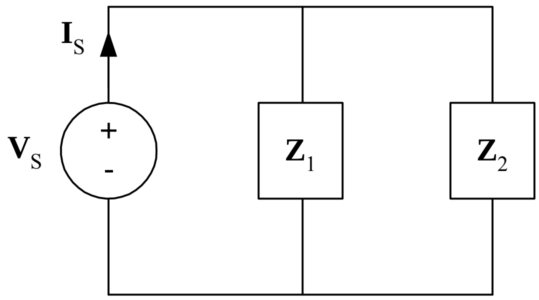
$$Z1 = 10 \angle 45^\circ \ \Omega$$
$$Z2 = 10 \angle -45^\circ \ \Omega$$

If you are to add a corrective load to change the power factor to 0.9 lagging, what will you add, a capacitive load or an inductive load? (Assume that the voltage source and real power delivered by said source do not change).

Name____

3. AC Steady State Power **[60 points]**

Consider the following circuit, where the source voltage has a magnitude of 120 V rms with a phase angle of 0°.



You are given the following information about the two loads:

$\mathbf{Z}_1$: Absorbs 10 kVA with a PF=0.2 lagging
$\mathbf{Z}_2$: Absorbs 4kW and -6kVAR

a. [20 points] Find the impedances (magnitude and phase) $\mathbf{Z}_1$ and $\mathbf{Z}_2$.

Name____

3. continued

b. [10 points] What is the current delivered by the source, $\mathbf{I}_S$.

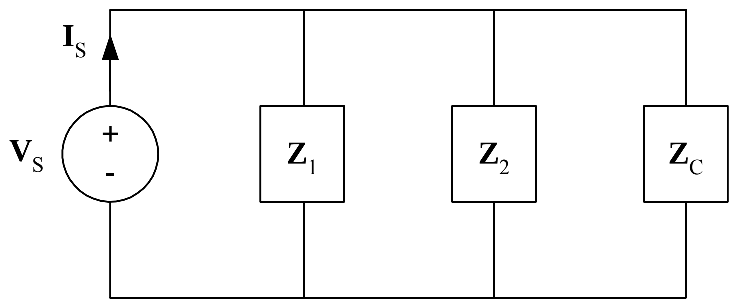
c. [10 points] What is the complex power delivered to the two loads?

d. [10 points] What is the power factor of the two loads combined?

Name____

3. continued

e. [10 points]

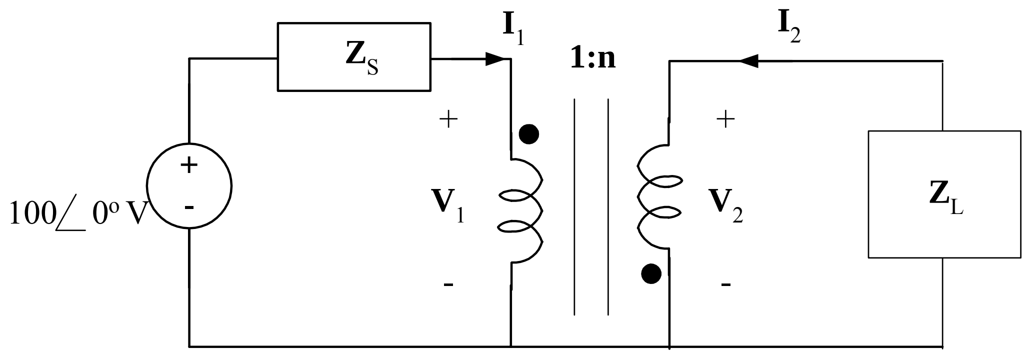


It is desired to add a new load in parallel with the other two loads, as shown above. The new load is to be designed to correct the power factor of the combined loads to 0.98 lagging. The real power delivered by the source, as well as the source voltage may not change. What is the impedance of the new load, Z_C?

Name____

4. Ideal Transformers and Maximum Power Transfer **[10 points]**

Consider the following ideal transformer circuit:



The source impedance Z_S = 20-j40 Ω.
The load impedance Z_L = 5+j10 Ω

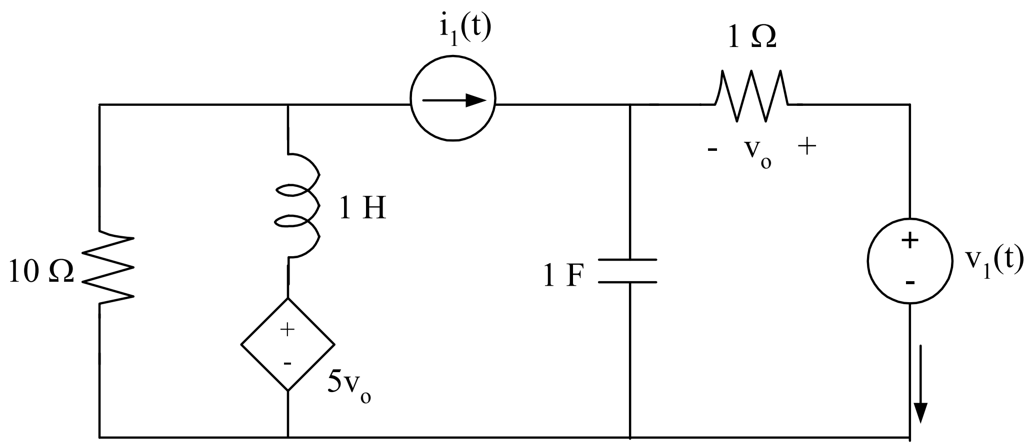
a. [10 points] What should the turns ratio, n, be such that the load, Z_L, will absorb the maximum amount of real power from the source in the primary?

b. [EXTRA 5 points] Is the above transformer a step-up or a step down transformer?

Name____

5. AC Steady State **[30 points]**

Consider the following circuit:



NOTE:

$v_1(t) = 4\cos(t+15°)$ V
$i_1(t) = 8\sin(t+30°)$ A

a. [10 points] Transfer the circuit from the time domain to the frequency domain (i.e. phasor domain)

Name____

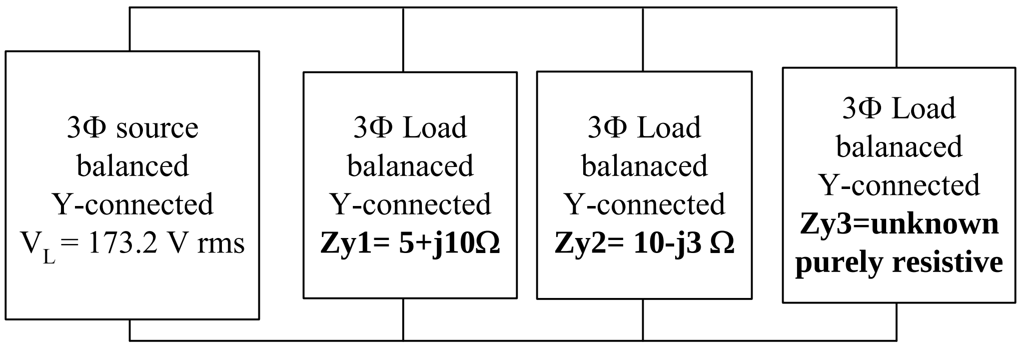
5. continued

b. [20 points] Using NODAL ANALYSIS, solve for phasor voltage $\mathbf{V_O}$.

Name____

6. Three Phase Systems **[40 points]**

You are given a balanced three phase Y-connected source that is connected in parallel to three balanced three phase Y-connected loads. A block diagram of the system is given below.



a. [10 points] Draw a block diagram of the single phase circuit of the three phase system labeled above. Make sure the label all pertinent voltages and currents and give the value of the line to neutral voltage, $\mathbf{V}_{an}$.

b. [10 points] What is the <u>single phase</u> real power absorbed by the loads, Z_{y1} and Z_{y2}?

Name____

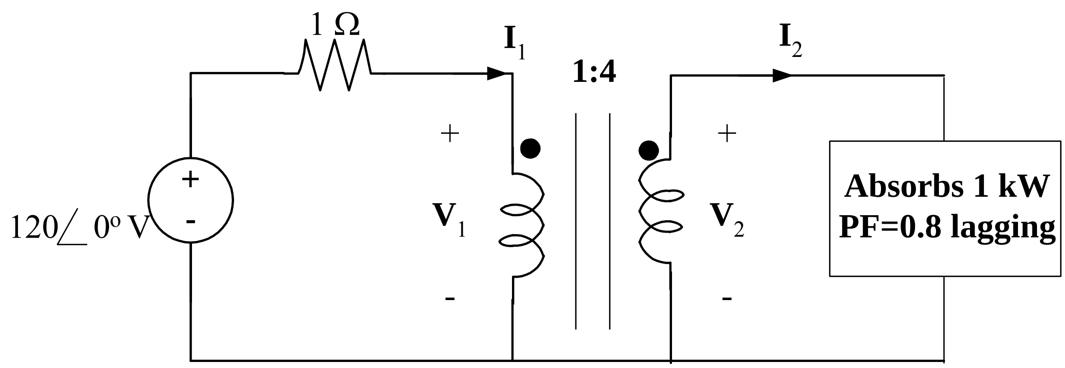
6 continued

c. [20 points] What is the unknown load if the total three phase real power delivered by the source is 6 kW?

Name____

7. Ideal Transformers **[20 points]**

Consider the following transformer



[20 points] Determine the voltages, $\mathbf{V}_1$ and $\mathbf{V}_2$ and the currents $\mathbf{I}_1$ and $\mathbf{I}_2$.

Name____

EXTRA CREDIT: Transformer Theory **[10 points]**

What is the difference between a mutually-coupled circuit with a coupling coefficient of 1 and a mutually-coupled circuit with a coupling coefficient of 0? (An example (i.e. a circuit diagram of each is sufficient explanation.)