Name: ______________________________

Instructor: ____________________________

Section/College: ________________________

Major: ☐ **Electrical Engineering** ☐ **Computer Engineering** **(Check one)**

Electrical Engineering Advancement Exam II

SPRING SEMESTER 2021

CLOSED BOOK, CLOSED NOTES

2 HOUR TIME LIMIT

CALCULATORS ARE ALLOWED

(calculators without communication capability only)

ELECTRONIC DEVICES WITH COMMUNICATION CAPABILITY MAY NOT BE USED DURING THE EXAMINATION

(electronic devices such as cell phone, pagers, and iPads)

(If such devices ring or are visible,

a 10% penalty will be given for the first occurrence and exam failure for the second.)

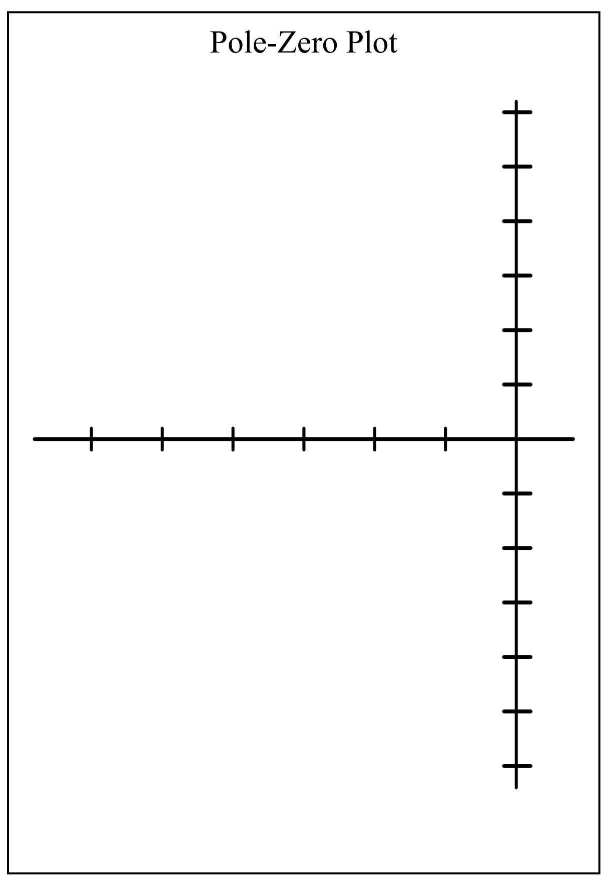
There are 10 problems: please look over the exam to make sure that you have 10 different problems. **Do any eight (8) problems!** Draw a large X through the two problems that you do not want to be graded. If you do not indicate which problems you want to leave out, the first 8 problems will be graded.

Do all work for each problem only on the page supplied for that problem (you may use both sides). **DO NOT**, for instance, continue Problem #3 on the back of Problem #2. Extra blank paper will be supplied if needed. If extra paper is used, show the additional work for each problem on a separate sheet, write your name and problem number on the sheet, and staple the extra sheet(s) to the appropriate problems.

Name ____________________________________

(1) The transfer function for a particular circuit is $H(s) = \frac{\mathbf{V_{out}}}{\mathbf{I_{in}}} = \frac{10s^2}{(s+3)(s+2+j)(s+2-j)}$.

a. What are the units of the transfer function? (1 pt.)
b. Sketch and label the pole-zero plot. (8 pts.)
c. Find the particular solution, $v_{out}(t)$, given the following input: $i_{in}(t) = 10e^{-t}\cos(5t + 45°)\,\text{A}$. (10 pts.)
d. Determine the differential equation with relates the input and output. (6 pts.)



Transfer function units = ____________________

$v_{out}(t)$ = ____

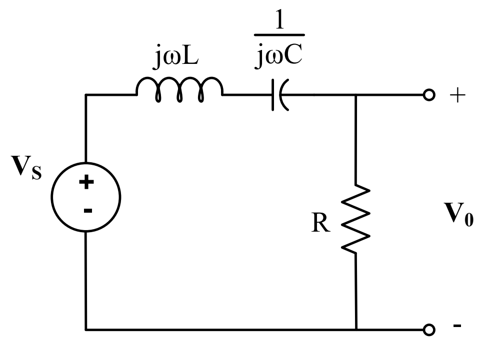
differential equation: ____

Problem Score

/25

Name ______________________________

(2) In the following filter,



a. Determine the magnitude of the transfer function, $|H(j\omega)|$ in terms of R, L, C and ω. (10 pts.)
b. Determine $|H(j0)|$ and $|H(j\infty)|$, the asymptotic behavior of the amplitude response. (4 pts.)
c. Given that R=5 **Ω**, calculate the values of L and C necessary if the bandwidth is to be 2000 rad/sec and the center frequency is to be 40,000 rad/sec. (10 pts.)
d. What type of filter is this: low-pass, high-pass, band-pass or band-reject? (1 pt.)

$|H(j\omega)| =$ ______________________________

$|H(j0)| =$ ______________

$|H(j\infty)| =$ ______________

L = __________________

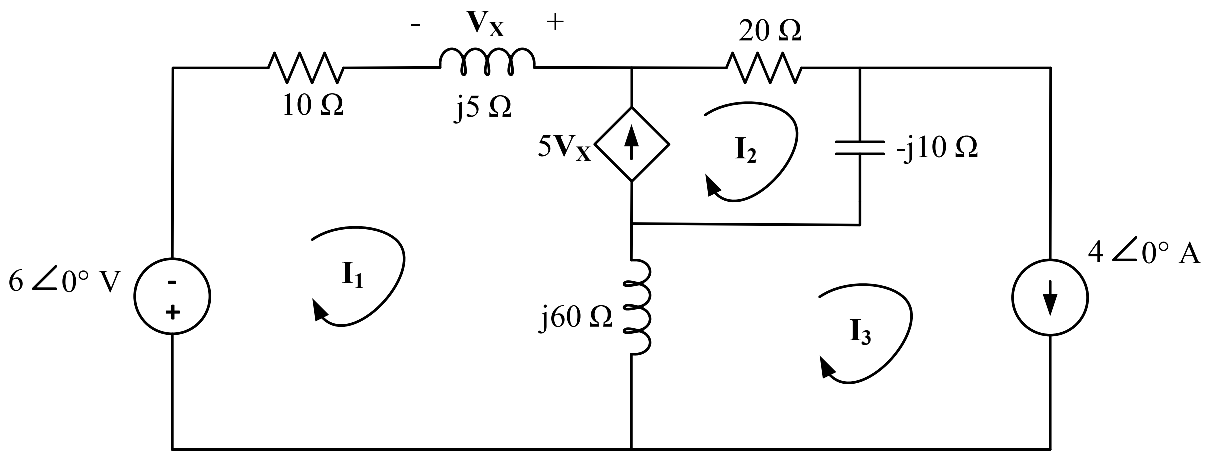
C = __________________

Filter type (circle one): low-pass high-pass band-pass band-reject

Problem Score
/25

Name ______________________________

(3) Write a set of phasor mesh current equations for the circuit to find $\mathbf{I_1}$, $\mathbf{I_2}$, and $\mathbf{I_3}$ in matrix form. You must eliminate the control variables from your equations. Do not solve.

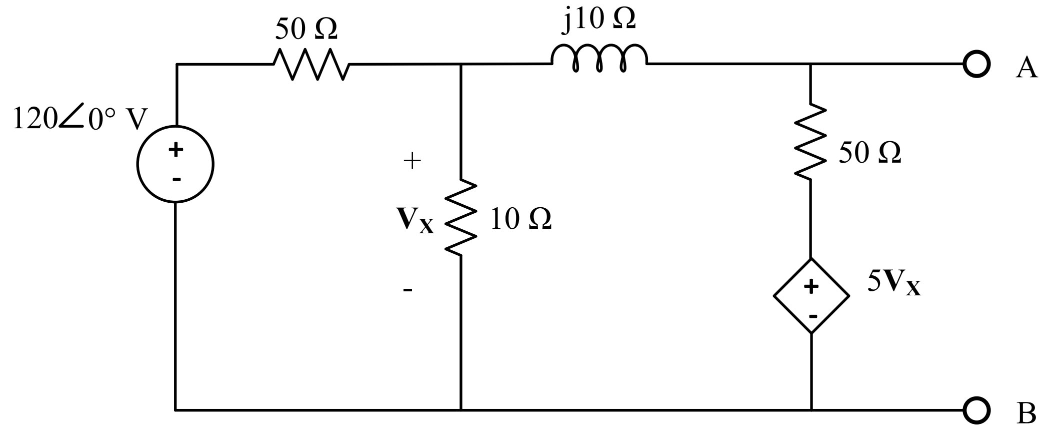


$$\begin{bmatrix} \quad & \quad & \quad \\ \quad & \quad & \quad \\ \quad & \quad & \quad \end{bmatrix} \begin{bmatrix} \mathbf{I_1} \\ \mathbf{I_2} \\ \mathbf{I_3} \end{bmatrix} = \begin{bmatrix} \quad \\ \quad \\ \quad \end{bmatrix}$$

Problem Score /25

Name ____________________

(4) Calculate the open circuit voltage, $\mathbf{V_{th}}$ or $\mathbf{V_{AB}}$, for the given circuit.

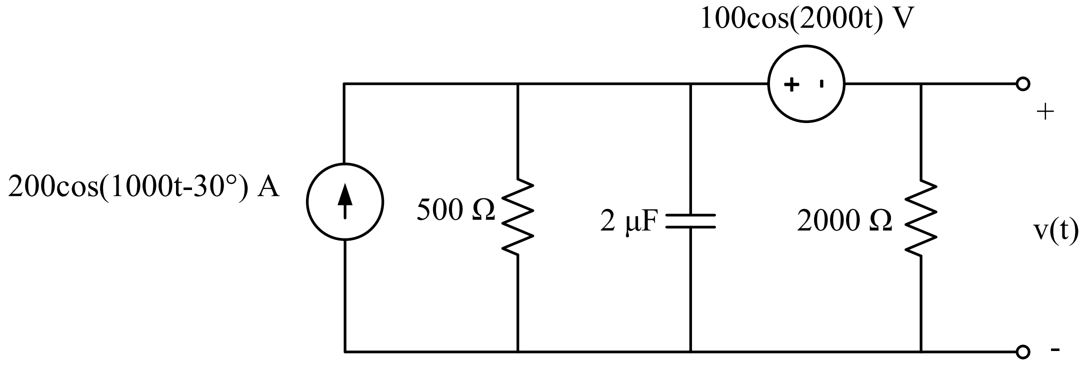


$\mathbf{V_{th}}=\mathbf{V_{AB}}$ = ____________________

Problem Score
/25

Name ______________________________

(5) For the following circuit, determine v(t) using superposition.



v(t) = ______________________________

Problem Score

/25

Name ______________________________________

(6) A single-phase load draws 70 A_{rms} at a power factor of 0.60 lagging from a 240-V_{rms} 60-Hz power line. To reduce the effective current drawn from the power line, a capacitance is placed in parallel with the load.

a. Find the value of capacitance necessary to increase the power factor of the load to 0.98 lagging. (15 pts.)
b. Find the RMS current drawn from the line after the capacitance found in part a is placed in parallel with the load. (5 pts.)
c. What should the power factor be corrected to so that the minimum current is drawn? (5 pts.)

C = ____________________________

I_{rms} = ____________________________

PF = ____________________________

Problem Score
/25

Name ____________________________________

(7) Two parallel single-phase loads are supplied by a 60-Hz, 208-V_{rms} sinusoidal source.
Load 1 absorbs 300 W at a power factor of 0.70 leading
Load 2 absorbs 450 VA at a power factor of 0.80. lagging.

a. Calculate the total complex power supplied by the source. (9 pts.)
b. Calculate the power factor of the combined loads. Include whether it is leading or lagging. (2 pts.)
c. Sketch and label the power triangle for Load 1. (7 pts.)
d. Calculate the impedance of Load 2. (7 pts.)

S_{total} = ____________________________________

PF_{total} = ____________________________________

Z_2 = ____________________________________

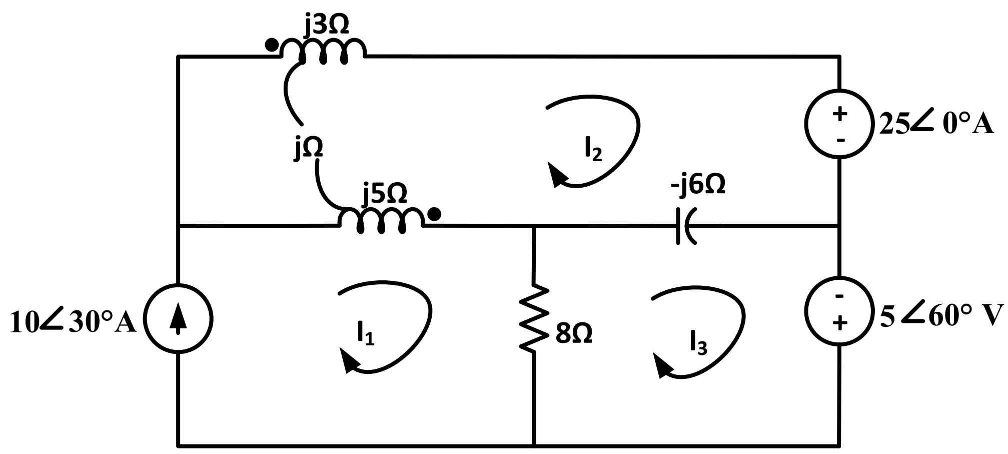
Power Triangle (Load 1)

Problem Score

/25

Name ______________________________

(8) For the circuit below,



Write a set of mesh current equations in the matrix form. Do not solve. (25 pts)

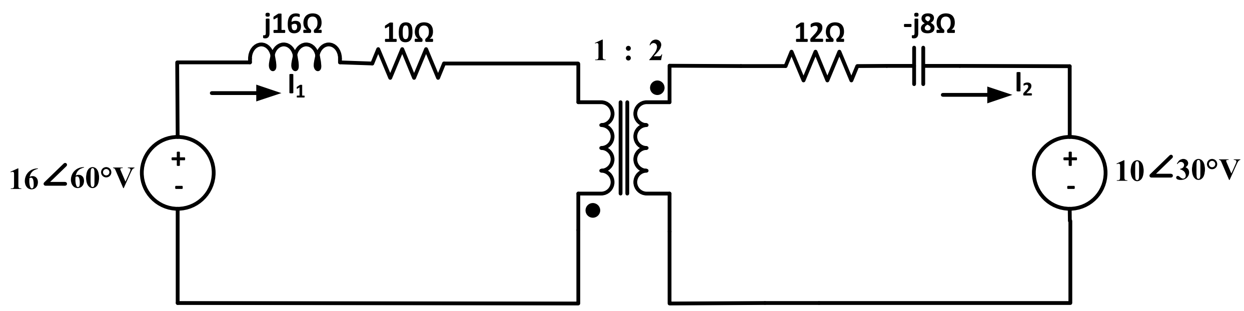
$$\begin{bmatrix} & & \\ & & \\ & & \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} \\ \\ \end{bmatrix}$$

Problem Score

/25

Name ___________________________________

(9) For the circuit below,



Find the currents $\mathbf{I_1}$ and $\mathbf{I_2}$. (Keep your answer in the polar form) (25 pts)

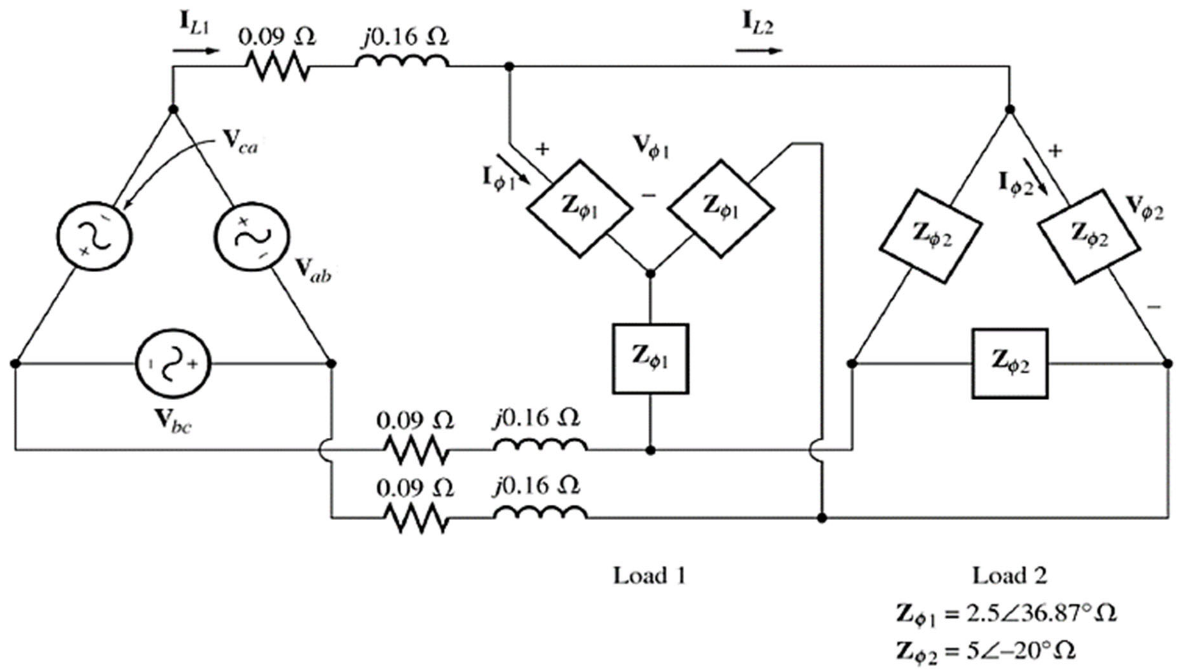
$\mathbf{I_1}$ = ___________________________________

$\mathbf{I_2}$ = ___________________________________

Problem Score
/25

Name ______________________________

(10) A three-phase power system shown below has two loads. The Δ −connected source is producing a line-to-line voltage of 480V and the line impedance is $(0.09+j0.16)\ \Omega$. Load 1 is Y-connected with an impedance of $2.5\angle 36.87^o\Omega$ and load 2 is Δ −connected with an impedance of $5\angle -20^o\Omega$.



a. Draw the per-phase equivalent circuit with correct values of all components. Take phase A line-to-neutral voltage to be your angle reference. **(5 points)**

b. What is the magnitude of the line-to-line voltage of the two loads? **(5 points)**

c. What is the magnitude of the line Current, I_{L1}? **(5 points)**

d. Find the **real** and **reactive** powers supplied to each load. **(10 points)**

Problem Score
/25