Name: _____

Instructor: _____

Section/College: _____

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

Electrical Engineering Advancement Exam II

FALL SEMESTER 2020

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.

Exam scores	
Question Number	**Out of 25 points**
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

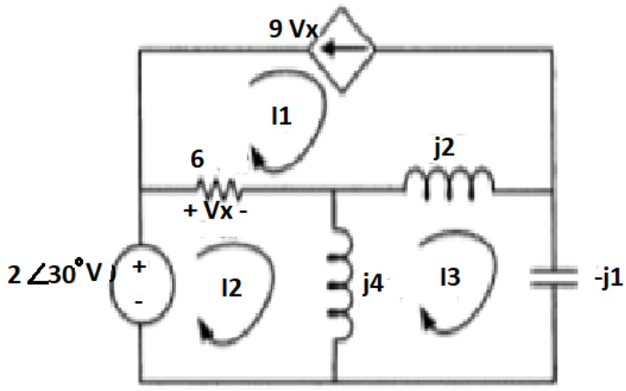
HONOR STATEMENT

"On my honor, I affirm that I will not give or receive any unauthorized help on this exam, that I have followed all of the exam instructions provided by the instructor, and that all work will be my own, in accordance with the Missouri S&T Student Council Honor Code (https://stuco.mst.edu/documents/honor-code/)."

Signature and Date_____

Name _____

(1) a. Write a set of mesh current equations for the circuit to find I_1, I_2 and I_3 in matrix form. You must eliminate the control variable from your equations. (**15 points**)
b. Solve for phasor mesh current I_2. (**5 points**)
c. Express steady state mesh current $i_2(t)$ in time domain if ω=1250 rad/s. (**5 points**)



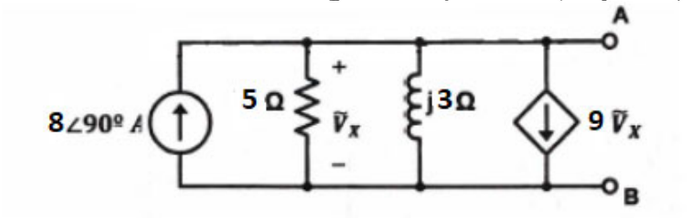
Problem Score
/25

Name _____

Problem Score
/25

Name _____

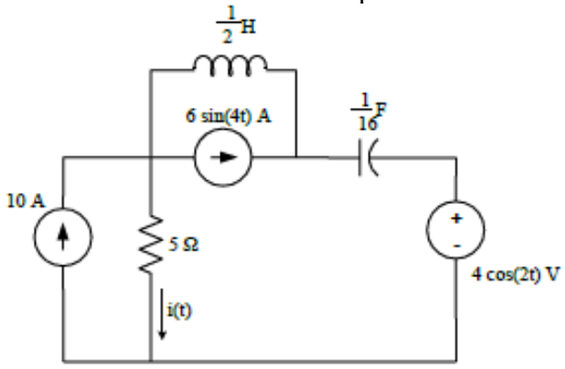
(2) Find and sketch the Thevenin Equivalent Circuit with respect to terminals A and B. Calculate the Thevenin voltage and impedance. (**25 points)**



Problem Score
/25

Name _____

(3) For the following circuit, determine the time domain current, $i(t)$ using Superposition. Show/draw the circuit used for each part of the solution. (**25 points**)



Problem Score
/25

Name _____

Problem Score
/25

Name _____

(4) A load draws $|\boldsymbol{S}|$=10,000 VA from a 60-Hz sinusoidal source at a power factor of 0.707 leading.

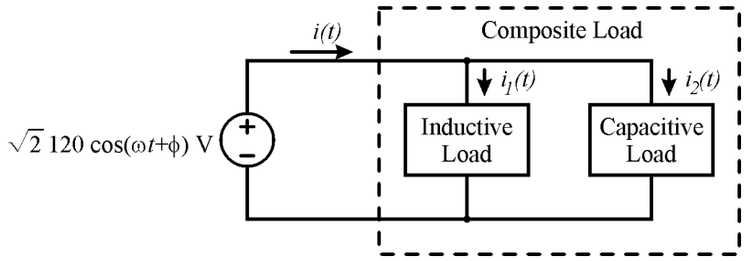
a. What is the average power delivered to the load? **(5 points)**
b. What is the reactive power delivered to the load? **(5 points)**
c. If V_{rms} = 120 volts, what is the peak current, I_m? **(5 points)**
d. What is the complex power, $\tilde{\boldsymbol{S}}$? **(5 points)**
e. What is the load impedance, $\tilde{\boldsymbol{Z}}$? **(5 points)**

Problem Score
/25

Name _____

(5) In the circuit below, an inductive load draws 1000 watts at power factor, PF = 0.9 lagging from a 120 V rms source. In an effort to raise the power factor seen by the source, a small capacitive load is placed in parallel with the inductive load. The capacitive load draws 10 watt at PF = 0.02 leading.

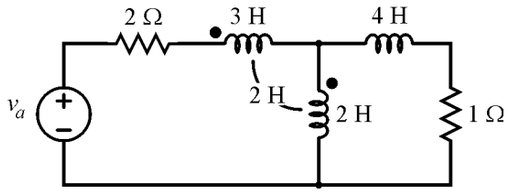
a. Find the complex power supplied by the source $\tilde{\boldsymbol{S}}_s$. **(10 points)**
b. Find the rms current supplied by the source, I_{rms}. **(5 points)**
c. Find the rms current supplied to the inductive load, I_{1rms}. **(5 points)**
d. Find the total impedance, $\tilde{\boldsymbol{Z}}$, with respect to the source. **(5 points)**



Problem Score
/25

Name _____

(6) Write two mesh current equations for the following circuit with mutual inductance M = 2H as indicated in the following figure. **(25 points)**



Problem Score
/25

Name _____

(7) The transfer function in s domain, H(s) of a circuit is given by

$$H(s) = \frac{I_o}{V_s} = \frac{(s+2)^2}{(s+3)(s^2+2s+10)}$$

a. If the input $v_s(t) = 5e^{-3t}\cos(2t + 30^0)$V, find the output $i_o(t)$. **(15 points)**

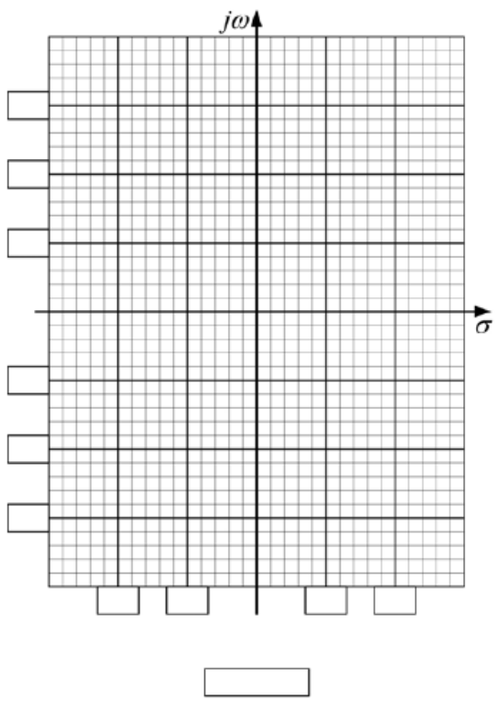
b. Identify the location of poles and zeros and sketch the pole-zero plot for the transfer function. **(10 points)**

$i_o(t)$ = _____

Location of poles: _____

Location of zeros: _____

Pole-zero plot:



Problem Score
/25

Name _____

(8) The transfer function in frequency domain of a circuit, $H(j\omega)$ is given by

$$H(j\omega) = \frac{V_{out}}{I_{in}} = \frac{(1 + j3\omega)}{(18 - 48\omega^2 + j20\omega)}$$

a. Develop the second order differential equation which models the circuit. **(10 points)**
b. If the input $i_{in}(t) = 50\sin(10t + 90^0)$A, find the output $v_{out}(t)$. **(15 points)**

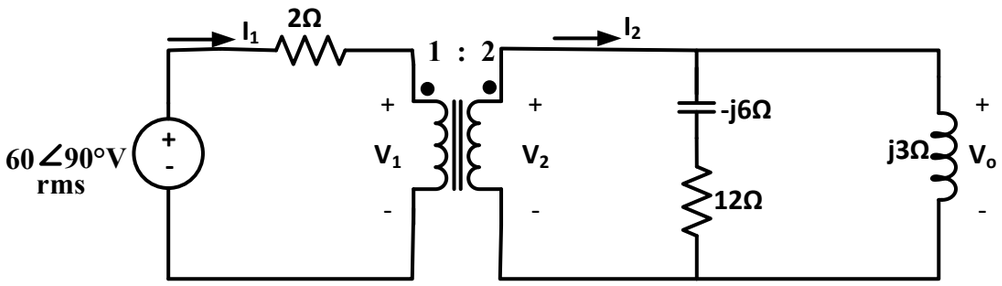
Differential Equation = _____

$v_{out}(t)$ = _____

Problem Score
/25

Name _____

(9) For the ideal transformer circuit below,



a. Find the currents $\mathbf{I_1}$ and $\mathbf{I_2}$. **(10 Points)**
b. Find the voltage $\mathbf{V_1}$, $\mathbf{V_2}$ and $\mathbf{V_o}$. **(10 Points)**
c. The complex power supplied by the source $\tilde{S}$. **(5 Points)**
(Note: Your answers should be in the **polar form**)

$\mathbf{I_1}$ = _____

$\mathbf{I_2}$ = _____

$\mathbf{V_1}$ = _____

$\mathbf{V_2}$ = _____

$\mathbf{V_o}$ = _____

$\tilde{S}$ = _____

Problem Score
/25

Name _____

(10) A balanced three-phase system consists of a source with a line-to-line voltage of 210V connected to the parallel combination of a delta-load $Z_\Delta = 24 - j30\Omega$ and a wye-load $Z_Y = 12 + j5\Omega$ through a line impedance $Z_{line} = 1 + j1\Omega$.

a. Draw the per-phase equivalent circuit representation. Take phase A line-to-neutral voltage to be your angle reference. **(7 points)**
b. Determine the magnitude of the line current of the combined loads. **(8 points)**
c. Determine the magnitude of the current flowing through the delta-connected load. **(5 points)**
d. Determine the magnitude of the current flowing through the wye-connected load. **(5 points)**

$|\mathbf{I_L}|$= _____

$|\boldsymbol{I_\Delta}|$ = _____

$|\boldsymbol{I_Y}|$ = _____

Problem Score
/25

Name _____

Problem Score
/25