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 and staple the extra sheet(s) to the appropriate problems.

<table>
<thead>
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<th>Exam scores</th>
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<tbody>
<tr>
<td>Question Number</td>
<td>Out of 25 points</td>
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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___________________________________________________
(1) a. Write a set of mesh current equations for the circuit to find I₁, I₂ and I₃ in matrix form. You must eliminate the control variable from your equations. (15)
b. Solve for phasor mesh current I₂. (5)
c. Express steady state mesh current i₂(t) in time domain if ω=1250 rad/s. (5)
(2) Find and sketch the Thevenin Equivalent Circuit with respect to terminals A and B. Calculate the Thevenin voltage and impedance. (25 points)
(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)
(4) Complex Power and/or Power Factor Correction (1 problem) HERE (25 points)
(5) Complex Power and/or Power Factor Correction (1 problem) HERE (25 points)
(6) Mutual Inductance Circuits (1 problem) HERE (25 points)

Problem Score

25
(7) The transfer function in s domain, \( H(s) \) of a circuit is given by

\[
H(s) = \frac{I_o}{V_o} = \frac{(s + 2)^2}{(s + 3)(s^2 + 2s + 10)}
\]

a. If the input \( v_o(t) = 5e^{-3t}\cos(2t + 30^\circ) \)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)

\[
i_o(t) = \frac{I_o}{V_o} = \frac{(s + 2)^2}{(s + 3)(s^2 + 2s + 10)}
\]

Location of poles:

Location of zeros:
(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 $i_{in}(t) = 50\sin(10t + 90^\circ)$A, find the output $v_{out}(t)$. (15 points)

Differential Equation = ______________________________________________________________________

$v_{out}(t) =$ ___________________________________________________________________________
(9) For the ideal transformer circuit below,

![Transformer Circuit Image]

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

$I_1 = \quad \quad V_1 = \quad \quad V_2 = \quad \quad I_2 = \quad \quad V_o = \quad \quad S = \quad \quad$
(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)

$|I| = \quad \quad \quad \quad \quad |I_{\Delta}| = \quad \quad \quad \quad \quad |I_Y| = \quad \quad \quad \quad \quad$