EECS 211 Circuits I  
Fall Semester 2018  
Exam #1 Date: 1 October 2018

NAME: ___________________________  KUID: ________

General Instructions

1. This exam is closed-book. You are allowed a non-communicating calculator and one side of one page (8.5" X 11") of notes.

2. Put your KUID on each page, in case the exam pages get separated.

3. There are 90 points possible on this exam.

4. Unless indicated otherwise, all resistances on this exam are in ohms (Ω), all voltages are in volts (V), and all currents are in amps (A).

5. You must give proper units for all numerical answers; points will be deducted for failure to do this.

6. When numerical values are requested, give your answers as decimal numbers (with units); that is, perform all calculations rather than leaving your answer as some complicated expression.

7. Clearly indicate your final answer to each problem by putting a box around it (not necessary for sets of equations).

8. Show your work:
   a. If your answer is incorrect, partial credit may be awarded based on the work shown. Even if your answer is correct, you will not receive full credit unless you have shown some work on the exam pages.
   b. Here are examples of what I mean by showing work. Clearly define (on the circuit diagram) any variables that you use in equations. Indicate what technique you are using (nodal analysis, etc.). Write out the equations you are using and indicate which law or laws each equation is based on. The bottom line is this: the easier it is for me to figure out what you are trying to do, the more likely I will be to award partial credit.
   c. Show all work on the exam pages. I have tried to leave lots of space for you to show (and check) your work, and the entire last page is available for continuing your work on any problem. Please do not use any other pages unless absolutely necessary. If you do use the last page or other paper, clearly indicate on the problem page that there is additional work elsewhere (and where that additional work is).
   d. You may use the circuit diagrams printed on the exam pages to show work -- you do not need to re-copy them unless you want to.

9. Stay calm. If you are having trouble with one problem (or part of a problem), leave it and go on. Even if you are not able to work one part of a problem, you may still be able to work subsequent parts.

10. Don’t forget to check your work. I have left space for this with several problems.

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2. Consider the circuit below. The square box represents some unspecified circuit element.

\[ + \quad V_R \quad - \]

\[ I_R \quad 10 \, \Omega \]

\[ 10 \, V \quad \boxed{\pm} \]

\[ + \quad 3 \, V \]

\[ - \]

a. (3 points) Find the value of the voltage variable \( V_R \).

\[ \text{KVL:} \quad -10 \, V + V_R + 3 \, V = 0 \]

\[ V_R = 10 \, V - 3 \, V = 7 \, V = VR \]

b. (3 points) Find the value of the current variable \( I_R \).

\[ \text{Ohm:} \quad I_R = -\frac{V_R}{10} = -\frac{7}{10} = -0.7 \, A = IR \]

c. (3 points) Find the value of the power supplied by the voltage source.

\[ \text{IR is in passive sign with 10V of V-source.} \]

\[ \text{So, } P_{\text{sup}} = -(10 \, V)(I_R) = (-10)(-0.7) = 7 \, W = P_{\text{sup}} \]
4. (8 points) Find the voltage $V_x$ in the circuit below.

\[ KVL: \quad -12 + 8I_x - 6V_x + 2I_x + 3I_x = 0 \quad V_x = 3I_x \]

\[ -12 + 8I_x - 6(3I_x) + 2I_x + 3I_x = 0 \]

\[ -5I_x = 12 \quad I_x = \frac{12}{-5} = -2.4 \ A \Rightarrow V_x = 3(-2.4) \]

\[ V_x = -7.2 \ V \]

Space for checking your work.

\[ -12 + 8(-2.4) - 6(-7.2) + 2(-2.4) + 3(-2.4) = \]

\[ -12 - 19.2 + 43.2 - 4.8 - 7.2 = 0 \ \checkmark \]
More space for the problem on the previous page.

Parallel \( (9 \oplus 9) \): \( \frac{9 \cdot 9}{9 + 9} = 4.5 \Omega 

\[ 4.5 \] \[ 15.5 \] Series

\[ 15.5 \] F G

\[ 4.5 + 15.5 = 20.5 \Omega = R_{eq} \]

\[ 20.5 \] F G
More space for the problem on the previous page.

\[
\begin{bmatrix}
1 & -1 & 0 \\
1 & 2 & -2 \\
0 & -5 & 7 \\
\end{bmatrix}
\begin{bmatrix}
V_1 \\
V_2 \\
V_3 \\
\end{bmatrix}
=
\begin{bmatrix}
3 \\
24 \\
-60
\end{bmatrix}
\]

- or -

\[
\begin{bmatrix}
1 & -1 & 0 \\
0.25 & 0.5 & -0.5 \\
0 & -0.5 & 0.7 \\
\end{bmatrix}
\begin{bmatrix}
V_1 \\
V_2 \\
V_3 \\
\end{bmatrix}
=
\begin{bmatrix}
3 \\
6 \\
-6
\end{bmatrix}
\]

Space for checking your work (which would involve solving the equations).

\[
\begin{bmatrix}
V_1 \\
V_2 \\
V_3 \\
\end{bmatrix}
=
\begin{bmatrix}
5.45 \\
2.45 \\
-6.82
\end{bmatrix}
\]

Check: KCL at ref. node:

\[
\frac{V_1}{4} + \frac{V_3}{5} = \frac{5.45}{4} + \frac{-6.82}{5} = 1.36 - 1.36 = 0 \checkmark
\]
More space for the problem on the previous page.

\[
\begin{bmatrix}
-1 & 0 & 1 \\
2k & -3k & 12k \\
0 & -3k & 15k
\end{bmatrix}
\begin{bmatrix}
I_1 \\
I_2 \\
I_3
\end{bmatrix}
= 
\begin{bmatrix}
4M \\
0 \\
0
\end{bmatrix}
\]

Space for checking your work (which would involve solving the equations).

\[
\begin{bmatrix}
I_1 \\
I_2 \\
I_3
\end{bmatrix}
= 
\begin{bmatrix}
-12 \\
-40 \\
-8
\end{bmatrix}
\text{mA}
\]

Check: KVL outside loop:

\[
2k I_1 + 5k I_2 - 6(3k)(I_2-I_3) + 7k I_2 + 9k I_3 =
\]

\[
= 2(-12) + 5(-40) - 18(-40-(-8)) + 7(-40) + 9(-8) =
\]

\[
= -24 -200 + 576 -280 -72 = 0 \checkmark
\]
More space for the problem on the previous page.

Mesh 1: \[ I_1 = \frac{V_X}{3k} = \frac{6kI_3}{3k} = 2I_3 \]

(1) \( I_1 + (0)I_2 + (2)I_3 = 0 \)

Mesh 2: \[ 4kI_2 + 2k(I_2 - I_1) + 12 = 0 \Rightarrow (2k)I_1 + (6k)I_2 + (0)I_3 = -12 \]

Mesh 3: \[ -12V + 4kI_3 + 6kI_3 = 0 \Rightarrow I_3 = 1.2mA \]

Then (Mesh 1): \[ I_1 = 2I_3 = 2.4mA \]

Then (Mesh 2): \[ I_2 = \frac{-12 + (2k)VA_4}{6k} \]

Then (Mesh 3): \[ I_2 = -1.2mA \]

\[ V_y = 2k(I_2 - I_1) = 2k(-1.2mA - 2.4mA) = -7.2V = V_y \]

Space for checking your work.