ECE 201 – Spring 2012
Exam #1

February 9, 2012

Division 0101: Lin (9:30am)
Division 0201: Narimanov (1:30 pm)
Division 0301: Capano (10:30 am)
Division 0401: Bermel (8:30 am)
Division 0501: Pomeranz (4:30 pm)

Instructions

1. DO NOT START UNTIL TOLD TO DO SO.

2. Write your Name, division, professor, and student ID# on your scantron sheet.

3. This is a CLOSED BOOKS and CLOSED NOTES exam.

4. Calculators are allowed (but not necessary).

5. If extra paper is needed, use back of test pages.

6. Cheating will not be tolerated. Cheating in this exam will result in an F in the course.

7. If you cannot solve a question, be sure to look at the other ones and come back to it if time permits.

8. As described in the course syllabus, we must certify that every student who receives a passing grade in this course has satisfied each of the course outcomes. On this exam, you have the opportunity to satisfy outcomes i, ii, and iii. (See the course syllabus for a complete description of each outcome.) On the chart below, we list the criteria we use for determining whether you have satisfied these course outcomes.

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<th>Course Outcome</th>
<th>Exam Questions</th>
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<th>Minimum # correct responses required to satisfy course outcome</th>
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<td>ii</td>
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If you fail to satisfy any of the course outcomes, don’t panic. There will be more opportunities for you to do so.
1. (a) Find the resistance of a carbon rod \((\rho = 40 \times 10^{-6} \Omega \cdot m)\) with \(L = 10 \text{ cm}\) and \(A = 0.01 \text{ cm}^2\).

(b) Find the current flow through the carbon rod when connected to an 8 V battery.

(c) Find the power dissipated by the carbon rod.

\[ R = 40 \times 10^{-6} \Omega \cdot \frac{10 \times 10^{-2}}{0.01 \times 10^{-4}} = 4 \Omega \]

\[ I = \frac{3}{4} = 2 \text{ A} \]

\[ P = RI^2 = 16 \Omega \]

(1) \(R = 2.45 \Omega, I = 3.67 \text{ A}, P = 33.1 \text{ W}\)

(2) \(R = 4.0 \Omega, I = 2.0 \text{ A}, P = 16.0 \text{ W}\)

(3) \(R = 4.0 \Omega, I = 2.0 \text{ A}, P = 36.8 \text{ W}\)

(4) \(R = 9.17 \Omega, I = 2.0 \text{ A}, P = 40 \text{ W}\)

(5) \(R = 24.5 \Omega, I = 0.367 \text{ A}, P = 3.31 \text{ W}\)

(6) \(R = 40. \Omega, I = 0.20 \text{ A}, P = 1.6 \text{ W}\)

(7) \(R = 400 \Omega, I = 0.020 \text{ A}, P = 0.16 \text{ W}\)

2. Determine the unknown current, \(I\) (in mA)

\[ \frac{20 \text{ V}}{10 \text{ k}\Omega} = 2 \text{ mA} \]
3. Mark the only statement that can be correct with respect to the following circuit.

\[ \begin{align*}
&- \quad 6V \quad + \\
&\quad \uparrow 4A \\
&\quad \downarrow 2A \\
&\quad \uparrow 1A \\
&\quad \downarrow 3A
\end{align*} \]

\[ \begin{align*}
&10V \\
&E1 \\
&\quad \uparrow 3A \\
&\quad \downarrow 10V \\
&E2 \\
&\quad \uparrow 4A \\
&\quad \downarrow 2A \\
&\quad \uparrow 1A \\
&\quad \downarrow 3A \\
&E3 \\
&\quad \uparrow 6V \\
&\quad \downarrow 16V \\
&\quad \uparrow 2A \\
&\quad \downarrow 10V
\end{align*} \]

(1) E1 is a 10Ω resistor, E2 is a 1.5Ω resistor, and E3 is a 3Ω resistor.
(2) E1 is a 10Ω resistor, E2 is a 1.5Ω resistor, and E3 is a 6V voltage source.
(3) E1 is a 10Ω resistor, E2 is a 6V voltage source, and E3 is a 3Ω resistor.
(4) E1 is a 10Ω resistor, E2 is a 6V voltage source, and E3 is a 6V voltage source.
(5) E1 is a 10V voltage source, E2 is a 1.5Ω resistor, and E3 is a 3Ω resistor.
(6) E1 is a 10V voltage source, E2 is a 1.5Ω resistor, and E3 is a 6V voltage source.
(7) E1 is a 10V voltage source, E2 is a 6V voltage source, and E3 is a 3Ω resistor.

4. Determine the unknown current, I (in mA)

\[ \begin{align*}
&10 \text{ kΩ} \quad \uparrow \quad I+1 \quad \downarrow \\
&\quad \downarrow 10 \text{ kΩ} \\
&1 \text{ mA} \\
&\quad I \\
&10 \text{ kΩ} \\
&20 \text{ V} \quad \uparrow
\end{align*} \]

(1) 0  (2) 0.25  (3) -0.25  (4) 0.5  (5) -0.5  (6) 1  (7) -1  (8) none of these

\[ \begin{align*}
10(I+1) + 10I &= 20 \\
20I &= 10 \\
I &= 0.5 \text{ mA}
\end{align*} \]
5. For this series-parallel circuit, find the equivalent resistance of all the resistors combined together?

(1) \( R_{eq} = R_1 + R_2 + R_3 + R_4 + R_5 \)
(2) \( R_{eq} = R_1 + R_5 + \frac{1}{(1/R_2 + 1/R_3 + 1/R_4)} \)
(3) \( \frac{1}{R_{eq}} = \frac{1}{R_4} + \frac{1}{(R_1 + 1/(1/(R_2 + R_3) + 1/R_3))} \)
(4) \( R_{eq} = R_2 + R_3 + R_4 + \frac{1}{(1/R_1 + 1/R_3)} \)
(5) \( \frac{1}{R_{eq}} = \frac{1}{R_2} + \frac{1}{(R_5 + 1/(1/R_3 + 1/(R_1 + R_4)))} \)
(6) \( R_{eq} = R_2 + R_5 + \frac{1}{(1/(R_3 + R_1) + 1/R_3)} \)
(7) \( \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} \)
6. Find the power delivered by the dependent source (in W):

\[ -0.75 V_1 \cdot V_1 = -12 \text{ W} \]

7. The power absorbed by each resistor is given in the circuit below. Find the current \( I_1 \).

\[ \frac{7 \Omega}{I_1} = \frac{2 \Omega}{I_2} \quad I_2 = \frac{I_1}{3} \quad I_1 + I_2 = \frac{4I_1}{3} \]

\[ \frac{100}{I_1 + I_2} + \frac{75}{I_1} = 100 \]

\[ \frac{100 \cdot 3}{4I_1} + \frac{75}{I_1} = 100 \]

\[ I_1 = 1.5 \text{ A} \]
8. In the circuit below, $g_m = 0.1$. Calculate the voltage $V_y$ (in V):

\[ V_x = 10 \text{ V} \]

\[ \frac{V_y}{10} = g_m V_x + 1 = 2 \]

\[ V_y = 20 \text{ V} \]
9. Using nodal analysis, find $V_B$ in the circuit shown below (in V):

\[
\begin{align*}
\frac{V_{BS}}{4} + \frac{V_{BS}}{5} + \frac{V_{BS} - V_C}{1} &= 0 \\
\frac{V_C - V_{BS}}{1} + \frac{V_C}{5} + \frac{V_C - 6}{1} &= 0 \\
5V_{BS} - 45 + 4V_{BS} + 20V_{BS} - 20V_C &= 0 \\
5V_C - 5V_{BS} + V_C + 5V_C - 30 &= 0 \\
29V_{BS} - 20V_C &= 45 \\
-5V_{BS} + 11V_C &= 20 \\
319V_{BS} - 220V_C &= 495 \\
-100V_{BS} + 220V_C &= 6000 \\
219V_{BS} &= 1095 \\
V_{BS} &= 5V
\end{align*}
\]
10. In the following circuit, \( R_1 = R_2 = R_3 = 1\Omega \), \( g_m = 1S \).
Use loop (mesh) analysis to express \( I_1 \) in terms of \( I_S \).

\[
\begin{align*}
V_x &= I_S - I_1 \\
I_1 + (I_1 - V_x) - V_x &= 0 \\
2I_1 - 2V_x &= 0 \\
2I_1 - 2I_S + 2I_1 &= 0 \\
I_1 &= 0.5I_S
\end{align*}
\]
11. Using superposition, find the value for \( i_x \) in the circuit below (in A):

\[
\begin{align*}
I_S &= 0: \quad i_x = \frac{40}{4 + 6} = 4 A \\
V_S &= 0: \quad 6i_x = 4(5 - i_x) \\
&\quad 10i_x = 20 \\
&\quad i_x = 2 A
\end{align*}
\]
12. What are the coefficients $\alpha$ and $\beta$ in:

$$v_o = \alpha V_s + \beta I_s$$

(1) $\alpha = -1/5$, $\beta = 1$
(2) $\alpha = -1/5$, $\beta = 3$
(3) $\alpha = -1/15$, $\beta = 2$
(4) $\alpha = 1/5$, $\beta = 1$
(5) $\alpha = 1/5$, $\beta = -1$
(6) $\alpha = 1/15$, $\beta = 3$
(7) $\alpha = 1/30$, $\beta = -2$

\[\begin{array}{c}
V_s + \frac{30}{60} V_l = \frac{30}{60} V_s \\
V_o = \frac{15}{30} V_l = \frac{15}{30} \cdot \frac{5}{5} V_s = \frac{L}{15} V_s \\
\alpha = \frac{1}{15}
\end{array}\]

If $V_s = 0$:
\[20 I_l = 30 (I_s - I_l)\]
\[50 I_l = 30 I_s\]
\[I_l = \frac{3}{5} I_s\]
\[V_o = 5 \cdot \frac{2}{5} I_s = 2 I_s\]

If $V_s = 0$:
\[\beta = 3\]
13. Two non-ideal independent voltage sources are connected in parallel. The first source has voltage $V_1$ and resistance $R_1$. The second source has voltage $V_2$ and resistance $R_2$. The parallel connection is a non-ideal voltage source with the following voltage and resistance:

1. $V_1 + V_2$, $R_1 + R_2$.
2. $V_1 + V_2$, $(R_1 R_2)/(R_1 + R_2)$.
3. $(R_2 V_1 + R_1 V_2)/(R_1 + R_2)$, $(R_1 R_2)/(R_1 + R_2)$.
4. $(R_2 V_1 + R_1 V_2)/(R_1 + R_2)$, $R_1 + R_2$.
5. $(V_1 V_2)/(V_1 + V_2)$, $R_1 + R_2$.
6. $(V_1 V_2)/(V_1 + V_2)$, $(R_1 R_2)/(R_1 + R_2)$.
7. $(R_1 V_1 + R_2 V_2)/(R_1 + R_2)$, $(R_1 R_2)/(R_1 + R_2)$.
8. $(R_1 V_1 + R_2 V_2)/(R_1 + R_2)$, $R_1 + R_2$.

\[ \frac{V_1}{R_1} + \frac{V_2}{R_2} = \frac{R_2 V_1 + R_1 V_2}{R_1 R_2} \]

\[ R_{1||R_2} \]

\[ R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{R_1 R_2}{R_1 + R_2} \]

\[ V_{eq} = \frac{R_2 V_1 + R_1 V_2}{R_1 R_2} \cdot \frac{R_1 R_2}{R_1 + R_2} = \frac{R_2 V_1 + R_1 V_2}{R_1 + R_2} \]