Exam #1
ECE 320: Fundamentals of Electrical Engineering
Fall 2011

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All Students:

- Exam is 50 minutes.
- Exam is closed book and notes.
- Answer questions as the directions state.
- You must show your work to receive full credit.
- Provide answers in the boxes provided.
- Be sure to include units on your answers as appropriate.
- No materials or calculators may be shared.
- No cell phone may be visible for any reason.
- Work only on the provided pages.
[1] (20 points)

Use source transformation and resistor combinations to simplify the circuit (Show your steps). Draw your final circuit with an equivalent voltage source and resistance. Find the current $I_0$ and the voltage $V_0$ across the 10Ω resistor and calculate the power absorbed.

\[
R_{eq} = \frac{6(4\Omega)}{6+4} = 3\Omega
\]

\[
I_0 = \frac{15V}{15\Omega} = 1A
\]

\[
V_0 = 1A(10\Omega) = 10V
\]

\[
P = VI = 10V(1A) = 10W
\]

<table>
<thead>
<tr>
<th>$V_0$</th>
<th>10V</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_0$</td>
<td>1A</td>
</tr>
<tr>
<td>$P_{10\Omega}$</td>
<td>10W</td>
</tr>
</tbody>
</table>
Use nodal analysis to solve for the circuit below. Find all node voltages and $V_1$, $V_2$, $V_3$, $V_4$.

\[ I_1 = I_2 + 4A \quad \therefore \quad I_1 = 16V - V_A \quad I_2 = \frac{V_A}{1\Omega} \]

\[ 16V - \frac{V_A}{1\Omega} = \frac{V_A}{5\Omega} + 4A \]

\[ 12A = \left(\frac{6}{5\Omega}\right)V_A \]

\[ V_A = 10V \]

\[ I_3 = V_B \quad I_4 = \frac{V_A - (-4V)}{3\Omega} \]

\[ 4A = V_B + \frac{V_B}{5\Omega} + \frac{4V}{3\Omega} \]

\[ \frac{8}{3}A = V_B \left(\frac{8}{15\Omega}\right) \]

\[ V_B = 5V \]

\[ I_1 = \frac{16V - 10V}{1\Omega} = 6A(1\Omega) = 6V = V_1 \]

\[ I_2 = \frac{10V}{5\Omega} = 2A(5\Omega) = 10V = V_2 \]

\[ I_3 = \frac{5V}{5\Omega} = 1A(5\Omega) = 5V = V_3 \]

\[ I_4 = \frac{5V + 4V}{3\Omega} = 3A \]

\[ (3A \times 3\Omega) = 9V = V_4 \]

\[ V_A \quad 10V \\
V_B \quad 5V \\
V_1 \quad 6V \\
V_2 \quad 10V \\
V_3 \quad 5V \\
V_4 \quad 9V \]
[3] (40 points)

Use **loop analysis** to solve for the circuit below. Find all loop currents and \(V_1, V_2, V_3, V_4\).

![Circuit Diagram]

**KVL supershmesh:**

1. \(\sum V = 0\)
   - \(V_1 + V_4 + 6V - 16V = 0\)
   - \(V_1 = I_A(2\Omega)\)
   - \(V_4 = I_C(2\Omega)\)

2. \(2\Omega I_A + 3\Omega I_C = 10V\)

3. \(8\Omega I_A - 3\Omega I_C - 3\Omega I_A - 3\Omega I_C + 3\Omega I_A = 0\)

\[\begin{align*}
&\text{A = x} \\
&\text{B = y} \quad \text{in calc.} \\
&\text{C = z} \\
&\text{V) } P_{v_d} = (-3V)(2\Omega - 3A) = 3W \quad \text{ats} \quad \checkmark
\end{align*}\]

\[
\begin{array}{|c|c|}
\hline
& I_A & 3A \\
& I_B & 6A \\
& I_C & 2A \\
\hline
V_1 & 6V \\
V_2 & 9V \\
V_3 & -3V \\
V_4 & 4V \\
\hline
\end{array}
\]

**Calculation:**

- \(A = 3\Omega\) \(\Rightarrow I_A = \frac{10V}{3\Omega} = 3.33A\)
- \(B = 6\Omega\) \(\Rightarrow I_B = \frac{10V}{6\Omega} = 1.66A\)
- \(C = 2\Omega\) \(\Rightarrow I_C = \frac{10V}{2\Omega} = 5A\)
- \(V_1 = 3A(2\Omega) = 6V\)
- \(V_2 = (6A - 3A)(3\Omega) = 9V\)
- \(V_3 = (3A - 3A)3\Omega = -3V\)
- \(V_4 = 2A(2\Omega) = 4V\)
[4] (20 points)

Use superposition principle to find the voltage $V_0$ and the current $I_0$. Then calculate the power absorbed by the 4Ω resistor. Redraw both circuits with only one source at a time.

\[
\begin{align*}
V_0 &= 4V \\
I_0 &= 6A \\
V &= 6A(4/5) = 4.8V \\
I &= \frac{2V}{4Ω} = 0.5A \\
I_{OB} &= 6/5 A
\end{align*}
\]