Exam 1b
October 23, 2002

ECE 221: Electric Circuits
Dr. McNames

- Write the first letter in your last name, your 6-digit identification number, and your student identification number below.
- Do not begin the exam or look at the problems until instructed to do so.
- You have 100 minutes to complete the exam.
- Do not use separate scratch paper. If you need more space, use the backs of the exam pages.
- If you have extra time, double check your answers. If you run out of time, write a note describing your strategy and equations that can be used to help solve the problem.

Problem 1:______ / 13
Problem 2:______ / 8
Problem 3:______ / 15
Problem 4:______ / 14

Total:______ / 50

First Letter in Last Name:_____________

6-Digit Identification Number:_____________

Student Identification Number:_____________
1. **Fundamental Concepts (13 pts)**

Use the following table and circuit diagram to answer the following questions. The column labeled PSC represents whether the passive sign convention (PSC) is satisfied for each circuit element.

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Current (I)</th>
<th>PSC (Y/N)</th>
<th>Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>3</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>b</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>-12</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>20</td>
<td>-5</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>2</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>f</td>
<td>15</td>
<td></td>
<td>-30</td>
</tr>
<tr>
<td>g</td>
<td>-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>5</td>
<td></td>
<td>20</td>
</tr>
</tbody>
</table>

a. (8 pts) Fill in the missing values in the table above.

b. (1 pt) Which circuit elements could be voltage sources? (Circle)

   a b c d e f g h

c. (1 pt) Which circuit elements could be resistors? Recall that resistors can only dissipate power. (Circle)

   a b c d e f g h

d. (1 pt) What is the total power absorbed in the circuit.

   \[ P_{\text{abs}} = \underline{\phantom{000}} \text{ W} \]

e. (1 pt) How many meshes are in the circuit?

   \[ m = \underline{\phantom{000}} \]

f. (1 pt) How many essential nodes are in the circuit?

   \[ n = \underline{\phantom{000}} \]
2. **Resistive Networks (8 pts)**

Find the equivalent resistance of the circuits shown below.

a. (2 pts)

\[
\begin{align*}
\text{a} & \quad \begin{array}{c}
\text{5 kΩ} \\
\text{12 kΩ} \\
\text{20 kΩ} \\
\text{9 kΩ} \\
\text{7 kΩ}
\end{array} \\
\text{b} & \quad \begin{array}{c}
\text{20 kΩ} \\
\text{9 kΩ} \\
\text{12 kΩ} \\
\text{2 kΩ}
\end{array}
\end{align*}
\]

\[R_{eq} = \, \ldots\]

b. (2 pts)

\[
\begin{align*}
\text{a} & \quad \begin{array}{c}
\text{2.5 kΩ} \\
\text{5 kΩ} \\
\text{9 kΩ} \\
\text{3 kΩ}
\end{array} \\
\text{b} & \quad \begin{array}{c}
\text{3 kΩ} \\
\text{4 kΩ}
\end{array}
\end{align*}
\]

\[R_{eq} = \, \ldots\]
2. Resistive Networks Continued (8 pts)
Find the equivalent resistance of the circuits shown below.

c. (2 pts)

\[ R_{eq} = \text{________} \]

\[ \begin{align*}
\text{a} & \quad 2 \, \text{k}\Omega & \quad 10 \, \text{k}\Omega \\
\text{b} & \quad 1 \, \text{k}\Omega & \quad 5 \, \text{k}\Omega
\end{align*} \]

\[ 3 \, \text{k}\Omega \]

\[ 8 \, \text{k}\Omega \]

\[ 3 \, \text{k}\Omega \]

\[ 5 \, \text{k}\Omega \]


d. (2 pts)

\[ R_{eq} = \text{________} \]

\[ \begin{align*}
\text{a} & \quad 9 \, \text{k}\Omega & \quad 5 \, \text{k}\Omega \\
\text{b} & \quad 7 \, \text{k}\Omega & \quad 9 \, \text{k}\Omega & \quad 1 \, \text{k}\Omega
\end{align*} \]

\[ 2 \, \text{k}\Omega \]

\[ 3 \, \text{k}\Omega \]
3. Mesh Current Method (15 points)

![Circuit Diagram]

a. (11 pts) Use the mesh-current method to write three independent equations in terms of the currents $i_a$, $i_b$, and $i_c$. Do not use any other variables in your equations. If appropriate, use a supermesh. You do not need to simplify your equations.

Equation 1:

Equation 2:

Equation 3:

b. (3 pts) Solve for the currents $i_a$, $i_b$, and $i_c$.

\[
i_a = \quad i_b = \quad i_c = \]

c. (1 pt) How much power is being absorbed by the dependent source?

\[P_{1000} = \]
4. Node Voltage Method & Supernodes (14 points)

![Circuit Diagram]

a. (9 pts) Use the node-voltage method to write three independent equations in terms of the node voltages \( v_1, v_2, \) and \( v_3 \). Do not use any other variables in your equations. If appropriate, use a supernode. You do not need to simplify your equations.

Eq. 1:

Eq. 2:

Eq. 3:

b. (3 pts) Solve for the node voltages \( v_1, v_2, \) and \( v_3 \).

\( v_1 = \) \hspace{1cm} \( v_2 = \) \hspace{1cm} \( v_3 = \)

c. (1 pt) What is \( i_a \)?

\( i_a = \)

d. (1 pt) What is \( v_\beta \)?

\( v_\beta = \)