Midterm Exam # 1  
March 2, 2004  
Time Allowed:  90 minutes

Name:_____________________, ______________________
Last                First

Student ID #:______________, Signature:______________________

Discussion Section:__________________________________

This is a closed-book exam, except for use of one 8.5 x 11 inch sheet of your notes. Show all your work to receive full or partial credit. Write your answers clearly in the spaces provided.

<table>
<thead>
<tr>
<th>Problem #</th>
<th>Points:</th>
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<tbody>
<tr>
<td>1</td>
<td>/20</td>
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<tr>
<td>2</td>
<td>/20</td>
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<tr>
<td>3</td>
<td>/10</td>
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<td>Total</td>
<td>/50</td>
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1. a) (2 points)

In the circuit shown in Figure 1(a), the independent source values and resistances are known. Given the indicated reference potential, list the unknown node potentials in the circuit of Figure 1(a).
b) (8 points)
Write down a complete set of node equations sufficient to solve for the node potentials you listed in part (a). Do not solve! Write your node equations in the box below.
c) (2 points)
How many meshes would be required to solve the circuit of Figure 1(a) by the mesh analysis method?

d) (8 points)

In the circuit of Figure 1 (d), the independent source values and resistances are known. Use the node voltage method to write three equations sufficient to solve for the node potentials $V_a$, $V_b$, and $V_c$. Write your equations in the box below. Do not solve!
2. a) (10 points)
Determine the Thevenin equivalent circuit for the circuit in Figure 2(a).
**Hint:** superposition. Write your answer in the box at the bottom of the page.

\[
\begin{align*}
V_{th} &= \\
R_{th} &= 
\end{align*}
\]
b) (10 points)

Network #1

Network #2

Figure 2(b)
One-port Networks #1 and #2 are interconnected as shown in Figure 2(b). Each of the one-port networks in Figure 2(b) is characterized by its indicated v-i graph. Determine the Thevenin equivalent network and the Norton equivalent networks for the one-port network shown in the figure by accessing the circuit at the terminals labeled a and b. Write your answer in the box below.

<table>
<thead>
<tr>
<th>$V_{th}= $</th>
<th>$R_{th}= $</th>
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</thead>
<tbody>
<tr>
<td>$I_N= $</td>
<td>$R_N= $</td>
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</table>
The op-amp in Figure 3 is ideal. The figure shows a temperature sensor modeled as a temperature-controlled current source. This device senses absolute temperature $T_A$ in the ($^\circ K$) Kelvin scale and delivers a current $kT_A$, where $k = 1 \mu A/\circ K$.

a) (5 points)
Determine the output voltage as a function of temperature $T_A (^\circ K)$ in terms of the circuit parameters.
b) (5 points)
Determine values for $R_1$ and $R_2$ so that the output voltage sensitivity is $100 \text{ mV/}^\circ K$ and the output is zero volts at $300^\circ K$. Write your answer in the box below.

$R_1 =$ \\
$R_2 =$