EECS 40 — MIDTERM #1
29 September 1999

Name: ________________________________
Last, First

Student ID: _______

Guidelines:
1. Closed book and notes except 1 page of formulas.
2. You may use a calculator.
3. Do not unstaple the exam.
4. Show all your work and reasoning on the exam in order to receive full or partial credit.
5. This exam contains 12 pages plus the cover page and 2 sheets of scratch paper included at the end of the exam. You can remove these from the rest of the exam if you wish.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Points Possible</th>
<th>Your Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

K = 10^3
m = 10^{-3}
\mu = 10^{-6}
n = 10^{-9}
p = 10^{-12}
f = 10^{-15}
Problem 1 “Static Logic” (20 points)

Fill in the logic values in the table below for input values given. Note that the value for “C” is given as an example.

Fill in boxes $\rightarrow$ (zero or 1)

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
</tr>
<tr>
<td>Value</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
e) All logic blocks in the above figures have a unit gate delay of 10 nsec.

Show the logic values versus time (for $t = 0$ to $70$ nsec) for outputs C and D of example a), given the logic input values (A and B) shown below:
Problem 2 “Circuit Solution by Inspection” (15 points)

Each of these problems should take no more than 1-2 minutes. WRITE ANSWER IN PLACE PROVIDED. There is no partial credit on these mini-problems.

a) Find $V_{AB}$

\[ V_{AB} = \quad \text{V} \]

b) Find $V_{CD}$

\[ V_{CD} = \quad \text{V} \]

c) Find power dissipated in 500K resistor

\[ P = \quad \text{W} \]
Problem 2 (cont.)

d) \[10V_X\]

Find \( V_X \) and \( V_Y \)

\[ V_X = \quad \text{V} \]
\[ V_Y = \quad \text{V} \]

e) \[\begin{array}{c}
20K \\
10K \\
50K \\
50K
\end{array}\]

Find \( R_{AB} \)

\[ R_{AB} = \quad \text{K}\Omega \]

f) \[\begin{array}{c}
3V \\
2V \\
4V \\
10K
\end{array}\]

Find \( I_1 \)

\[ I_1 = \quad \text{\mu A} \]

g) \[\begin{array}{c}
1mA \\
2mA \\
3mA \\
1.9K \\
1.3K
\end{array}\]

Find \( V_X \)

\[ V_X = \quad \text{V} \]
Problem 3 “Initial Conditions” (15 points)

In each of the problems below, find the value of the current or voltage just after the switch moves 
(t = 0+). (What is requested is just a numerical value, NOT an equation or function of time.)

a) \[ V_0 = 0.1 \text{pF}, \quad 20 \text{KΩ} \]

pre-charged to \[ V_0 = 1 \text{V} \]

\[ i_R = \quad \mu\text{A} \]

b) \[ 1 \text{MΩ}, \quad 50 \text{fF} \quad 1 \text{MΩ} \]

\[ V_C = \quad \text{V} \]

c) \[ 1 \text{KΩ}, \quad 1 \text{mA}, \quad 1 \text{KΩ} \]

\[ i_1 = \quad \text{mA} \]

d) \[ 3 \text{V}, \quad 100 \text{KΩ} \quad 200 \text{KΩ} \quad 100 \text{pF} \]

\[ V_X = \quad \text{V} \]
Problem 4 “Nodal Analysis” (20 points)

a. For the circuit below you are asked to write sufficient equations to find the unknowns. **You MUST put the equations into the space indicated.** Do any scratch work on the page opposite. **Do not solve.**

![Circuit Diagram]

Unknowns: $V_a$, $V_b$, $V_c$

Write final equations here:

- \[ I_{AA} + I_{BB} = 0 \]
- \[ V_{CC} - V_a = I_{BB} R_1 \]
- \[ V_{DD} - V_c = I_{BB} R_5 \]
b. Similar to part a, you are asked to write sufficient equations to find the unknowns. Do not solve. **You must** put the equations in the space indicated below.

Unkowns: $V_a$, $V_b$, $V_c$

Put final form for equations here:

\[
\begin{align*}
\text{Unknowns: } V_a, V_b, V_c \\
\text{Put final form for equations here:} \\
\end{align*}
\]
Problem 5 (15 points)

The following circuit is used to study one phase of the operation of a DRAM cell — the slow decay of a stored “1”. First the switch $S_1$ is closed and kept closed to write a “1”. Then it opens and the storage capacitor $C_B$ is supposed to maintain the stored information. In this memory, a valid “1” is any voltage $v_B$ in the range of 1 to 3V.

![Circuit Diagram]

a) What is the value of $v_B$, just after the switch $S_1$ opens, i.e., at $t = 0^+$? (1% accuracy is sufficient.)

\[ v_B = \phantom{0} \text{V} \]

b) What is the value of $v_B$ much later (e.g., 1 hour later)?

\[ v_B = \phantom{0} \text{V} \]

c) On the axes provided on the facing page, neatly sketch the graph of $v_B(t)$ versus time. You must label axes with units.

d) Write an equation for $v_B$ as a function of time.
Figure 5.1: Graph of $v_B(t)$ against $t$. The graph shows the velocity of object B as a function of time.
Problem 6 (15 points)

a) Find the Thévenin Equivalent Circuit of the following:

\[ V_T = \underline{\text{___________}} \text{ V} \]
\[ R_T = \underline{\text{___________}} \text{ K} \]

b) Find the Norton Equivalent of the following linear circuit:

\[ I_N = \underline{\text{___________}} \text{ mA} \]
\[ R_N = \underline{\text{___________}} \text{ K} \]

c) Find the power supplied by the 12V voltage source in the following circuit.

\[ \text{Power out} = \underline{\text{___________}} \text{ W} \]