EECS 40, Fall 2006  
Prof. Chang-Hasnain  
Midterm #1

September 27, 2006  
Total Time Allotted: 50 minutes  
Total Points: 100

1. This is a closed book exam. However, you are allowed to bring one page (8.5” x 11”), single-sided notes
2. No electronic devices, i.e. calculators, cell phones, computers, etc.
3. SHOW all the steps on the exam. Answers without steps will be given only a small percentage of credits. Partial credits will be given if you have proper steps but no final answers.
4. Draw BOXES around your final answers.
5. Remember to put down units. Points will be taken off for answers without units.

Last (Family) Name: ________________________________________________________
First Name: ______________________________________________________________
Student ID: ___________________________ Discussion Session: ________________
Signature: ________________________________________________________________

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<tbody>
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<td>Problem 1 (50 pts)</td>
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<td>Problem 2 (50 pts):</td>
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1. (50 pts) Equivalent circuit.

(a) (5 pts) What is the current $i_1$ through the 5 Ohm resistor?

(b) (5 pts) Use KVL, write down the equation for $V_x$ in terms of $V_1$ and/or $V_2$.

(c) (5 pts) Use KCL, write down the equation for $V_1$ and solve for $V_1$.

(d) (5 pts) Use KCL, write down the equation for $V_2$ and solve for $V_2$. 

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Page 2 of 6
(e) (5 pts) Solve for $V_{out}$ (this is simply the Thevenin Voltage)

(f) Now we short the two end terminals.

(5 pts) What is $V_1$ ?

(g) (5 pts) What is $V_x$ ?

(h) (5 pts) What is $I_{sc}$ ?
(i) (5 pts) what is the Thevenin Resistance?

(j) (5 pts) Draw the Thevenin Equivalent Circuit.
2. For \( t < 0 \), the switch was open and \( V_{\text{out}} = 0 \). At \( t = 0 \text{s} \), S1 closes. **NOTE:** \( \mu = 10^{-6} \); \( k = 10^3 \); \( e^1 = 0.37 \); \( e^2 = 0.14 \) **Remember to put down units.**

(a) (12 pts) Construct the differential equation of \( V_{\text{out}} \) in terms of all the given quantities. **Hint:** you may solve this use Mesh or Nodal analysis, or, even simpler, Thevenin equivalent circuit. Write all your steps.

(b) (5 pts) Write a closed-form expression for \( V_{\text{out}}(t) \) for \( t > 0 \)

(c) (8 pts) Plot \( V_{\text{out}} \) as a function of time \( t = 0 \) to \( t = 100 \text{ms} \). **Label the y-axis and all key points:** starting value, 1 time constant value, value at infinity.
(d) (5 pts) As $t$ approaches infinity, what value will $i_3$ approach?

(e) (5 pts) Now, suppose someone disturbed the circuit and S1 is re-opened at 40 ms again! Construct the new differential equation.

(f) (6 pts) What is the new time constant? What is the new expression for $V_{out}(t)$ for $t>40$ ms.

(g) (5 pts) In this case, as $t$ approaches infinity, what value will $i_3$ approach?

(h) (5 pts) Plot the new $V_{out}$ from $t=0$ ms to 100 ms to include the re-opening of the switch at 40 ms. **Label the y-axis and all key points:** starting value, value at switching point, 1 time constant values, value at infinity.