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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<td>Problem 1 (50 pts)</td>
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2. For t<0, the switch was open and $V_{out}=0$. At t=0s, S1 closes. NOTE: $D=10^6$; $k=10^3$; $e^1=0.37$; $e^2=0.14$ Remember to put down units.

(a) (12 pts) Construct the differential equation of $V_{out}$ 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 $V_{out}(t)$ for t>0

(c) (8 pts) Plot $V_{out}$ as a function of time t = 0 to t = 100ms. 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.
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 $V_2$
(e) (5 pts) Solve for $V_{\text{out}}$ (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.