E84 Final Exam: Spring 2007

You have at least 3 hours to complete this closed book, open equation sheet exam. I'm not going to kick you out, but in the interest of fairness to those that have other exams on the exam day, I will start asking for them after about 4 hours. There are 9 problems. The point distribution is listed below. Time estimates are not listed; however, the point distribution should indicate approximate length. The problems are in no particular order. As in the previous exams, you should realize that you will get the most credit for showing that you understand the concepts involved in the problem. This does not mean simply listing everything that you know about a particular type of device or relaying things that could be copied from an equation sheet – instead, I'm looking for careful analysis of the problem at hand. If there is a stumbling block between you and a final answer, explain what that stumbling block is, make an assumption and move on. If you're really stuck, come talk to me and I might be able to give a nudge (in trade for a point or two). Obviously, the scale of your assumptions and their impact on the solution will determine how much partial credit is possible.

There are no purposeful ambiguities on this test. If you have any questions, ask. Please show all work. State any assumptions where relevant. Show all units in your final answers. Make it clear where your final answer is.

Good luck!!!

Name:____

Problem 1: __________/ 10

Problem 2: __________/ 8

Problem 3: __________/ 16

Problem 4: __________/ 14

Problem 5: __________/ 10

Problem 6: ___________/8

Problem 7: ___________/10

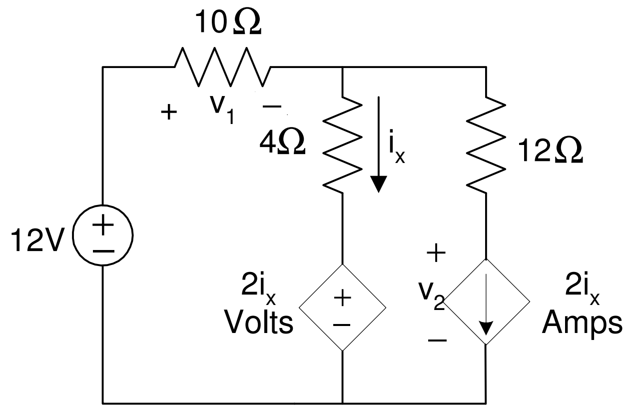
Problem 8: ___________/12

Problem 9: ___________/10

Problem 10: ___________/2

Total: ______________/ 100

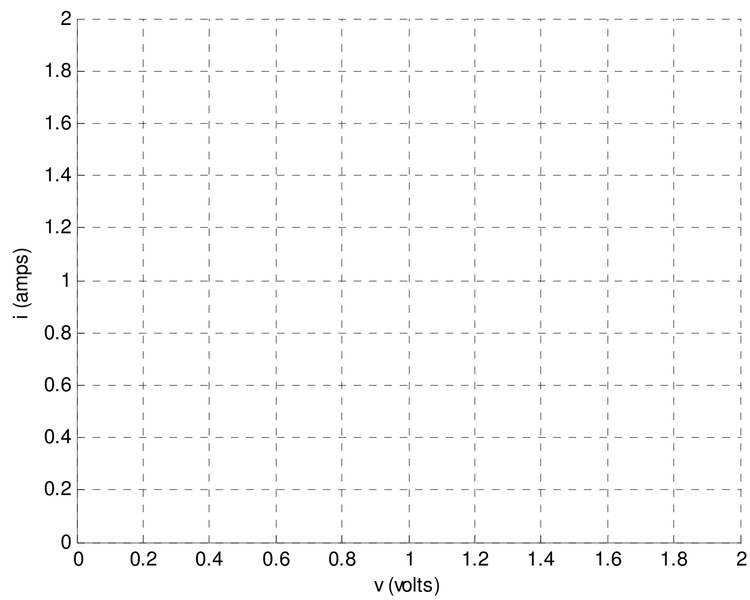
Problem 1 (10 points)



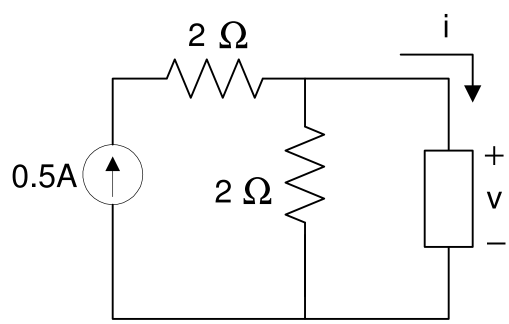
Solve for v_1 (the voltage across the 10Ω resistor) and v_2 (the voltage across the dependent current source).

v_1=________________________________, v_2=________________________________

Problem 2 (8 points)



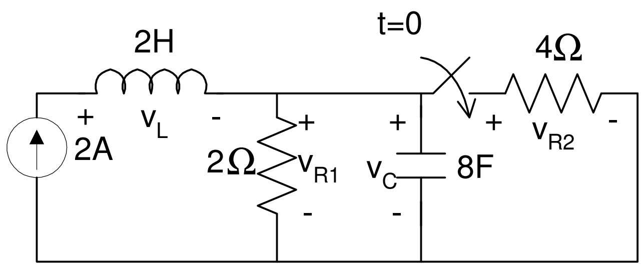
The i-v characteristic curve for a particular "black box" is shown above. The device is used in the circuit below.



Graphically determine the values for i and v.

i = ____________________________, v = ________________________________

Problem 3 (16 points)



(3a) In the table below, use DC approximations/replacements to calculate the voltages and the currents. Use the polarities as labeled in the figure above and assume that the currents requested are the values traveling from the positive to the negative sign. So, for example, if you find a 100A current is flowing from right to left through the inductor, you would fill out "-100A" in the i_L slot since i_L represents the current flowing from left to right (in that specific case).

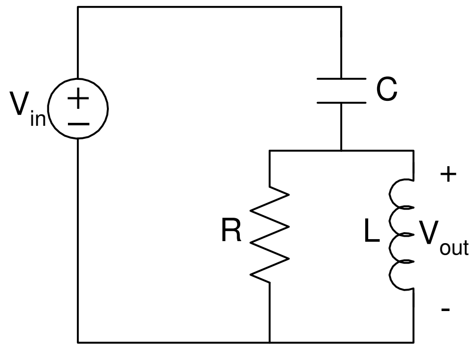
Fill out the following chart:

	t=0⁻	**t=0⁺**	**t=∞**
i_{R1}	**A**	**A**	**A**
v_{R1}	**V**	**V**	**V**
i_L	**A**	**A**	**A**
v_L	**V**	**V**	**V**
i_C	**A**	**A**	**A**
v_C	**V**	**V**	**V**
i_{R2}	**A**	**A**	**A**
v_{R2}	**V**	**V**	**V**

Problem 3 (continued)

(3b) Draw the Thevenin Equivalent of the circuit well after the switch has closed as seen by the terminals that hold the 4Ω resistor. Note: you can use t=∞ and make DC assumptions for the inductor and capacitor. 2nd note: If you spend more than 2 minutes on this, you're doing something wrong.

Problem 4 (14 points)



(4a) Find an expression for the transfer function in terms of s. Normalize your answer such that the coefficient of the highest order of s is unity.

Transfer Function: ____

Problem 4 (continued)

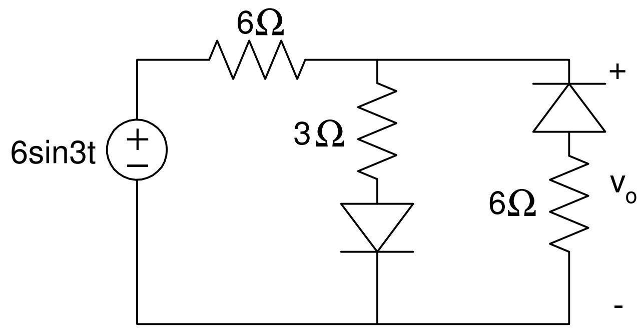
(4b) Assuming R=6Ω, C=1/30F, L=5H. What is the forced response, $v_{out}(t)$, if $v_{in}(t) = 3e^{-4t}\ Volts$?

$v_{out}(t)$ = ____

(4c) Using the same values as above, what is the complete response, $v_{out}(t)$, if $v_{in}(t) = 3e^{-4t}u(t)\ Volts$?

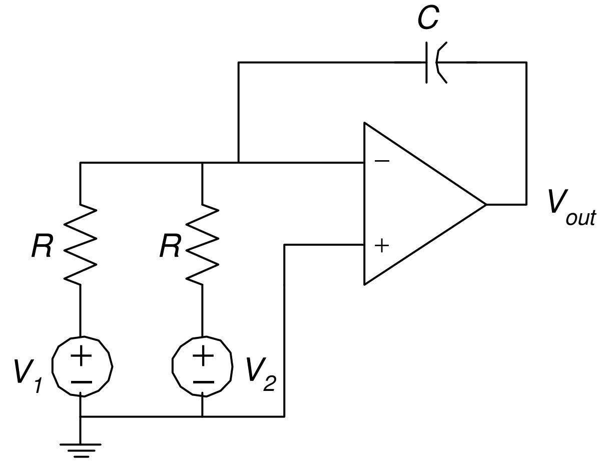
$v_{out}(t)$ = ____

Problem 5 (10 points)



Find and plot v_o. Label your plot as clearly as possible and make it abundantly clear that you know what is going on. Note: The diodes in this problem are IDEAL diodes.

Problem 6 (8 points)

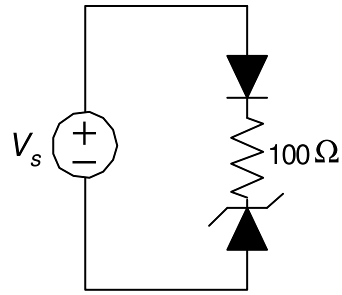


Write an expression for *Vout(t)* in terms of $V_1(t)$ and $V_2(t)$. Your final expression should not contain a "*jω*" or an "*s*" term. What does this circuit do (it should be obvious from your expression)?

v_{out}(t) = ____

What does it do? ____

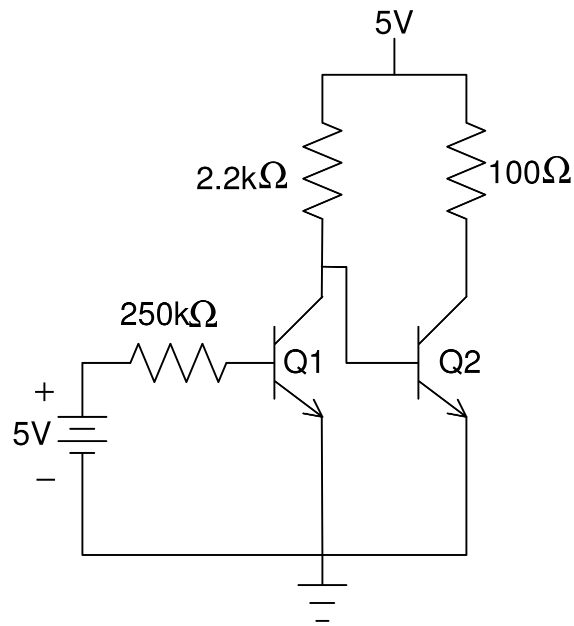
Problem 7 (10 points)



The diodes above are both real diodes. Both diodes are made of silicon, and thus have an η of 2. V_T is $\frac{300}{11{,}586}$ for each diode. The zener diode has a breakdown voltage of 5 volts. Both diodes have an *Is* of 10 nA. These diodes are rated for a maximum forward bias voltage of 0.8 Volts and a maximum forward current of 60mA. If you find these values to be inconsistent, simply use the more limiting value. If either of these values are exceeded, the diode is permanently destroyed. The regular (non-zener) diode will also be destroyed if its voltage goes below -6V. What range must V_s be kept in to prevent either diode from being permanently destroyed? As ridiculous as it may be, provide an answer to the hundredths place wherever possible.

Range of Vs: ____

Problem 8 (12 points)

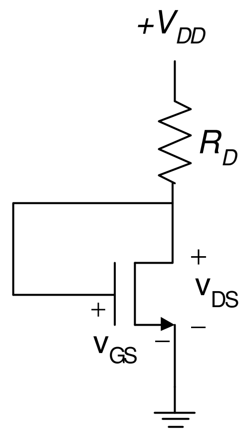


(8a) The npn BJTs used in the circuit above have a $\beta=100$. Given that both transistors are active, calculate i_{C1}, v_{CE1}, i_{C2} and v_{CE2}.

$\mathbf{i_{C1}}$ = ______________________________, $\mathbf{v_{CE1}}$ = ____________________________

$\mathbf{i_{C2}}$ = ______________________________, $\mathbf{v_{CE2}}$ = ____________________________

Problem 8 (continued)



(8b) For the MOSFET circuit shown above, the depletion NMOS transistor has I_{DSS} = 4mA and V_p = -4V. Given that V_{DD} = 10V and v_{DS}=6V: find v_{GS}, the region of operation, i_D and R_D.

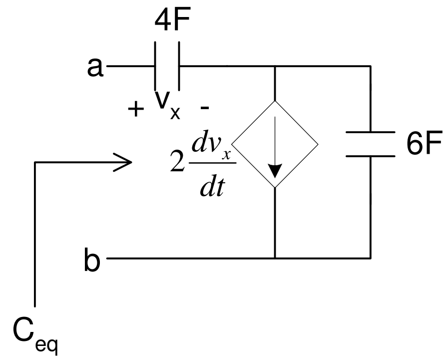
v_{GS} = ____

Region of operation: _________________________

i_D = ____

R_D = ____

Problem 9 (10 points)



Find the equivalent capacitance, Ceq, of the circuit as seen by the two terminals, a and b.

Ceq = ____

Problem 10 (2 points)

What was the one thing that you were really hoping was on the test, but wasn't?