Midterm Solutions and

GRADING

UNIVERSITY OF CALIFORNIA, BERKELEY
Department of Electrical Engineering and Computer Sciences

EE 100/EE 42 — Summer 2005
Intro. To Electronics Engineering — Bharath "Bart Simpson" Muthuswamy

MIDTERM
July 15th 2005
Time Allotted: 3 hours

NAME: ________________________________ , ______________________
(print) Last First

STUDENT ID#:______________

I WILL NOT CHEAT ON THIS EXAM. Signature:____________________

Note(s):

1. **You will receive [3 pts] for filling out the information above.**
2. **MAKE SURE THE EXAM HAS 10 NUMBERED PAGES.**
3. **This is a CLOSED BOOK exam. However, you may use one 8.5 x 11" of notes (both sides) and a calculator.**
4. **SHOW YOUR WORK on this exam. MAKE YOUR METHODS CLEAR TO THE GRADER so you can receive partial credit.**
5. **WRITE ANSWERS CLEARLY IN THE SPACES (lines or boxes) PROVIDED.**
6. **Remember to specify units on answers whenever appropriate.**
7. **If you are asked to setup equation(s) only, do NOT attempt to solve the equation(s).**

SCORE: This page: ______ / 3

1:______ / 30

2:______ / 30

3:______ / 25

4:______ / 12

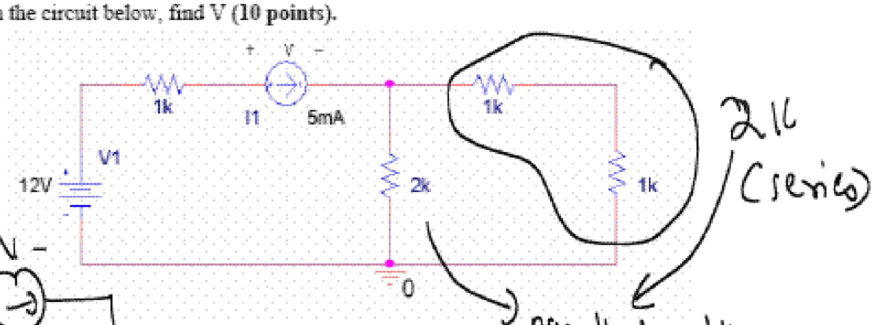
TOTAL:______ / 100

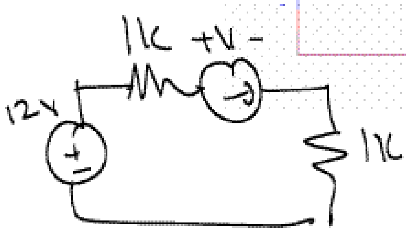
NOTE: Do NOT email me (or the TAs or the reader) grade correction request(s) → bring it to my office hours (deadline: 07/27/05)

Problem 1 (30 points)

HINT: Nodal analysis is not necessary for this problem because the circuits can be solved by inspection.

(a) In the circuit below, find V (**10 points**).



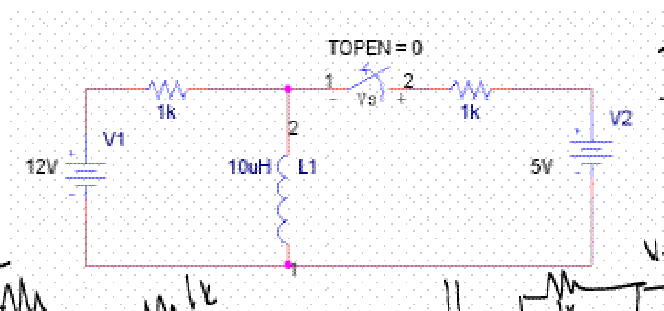


KVL: $12 - (1k)\,5mA - V - (1k)\,5mA = 0$

Neglect ΔV across any resistor → −5

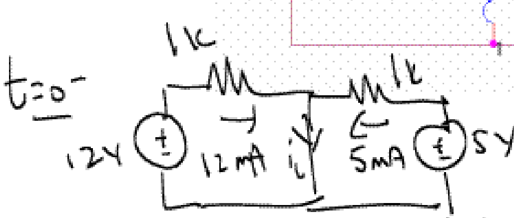
V = 2 V

(b) In the circuit below, the switch has been closed for a long time before opening at t = 0. Find Vs at $t = 0^+$. (**10 points**).

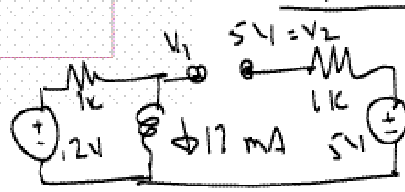


t=0+:

$i_L(0^+) = i_L(0^-)$
$= 17\ mA$



$i_L(0^-) = 17\ mA$

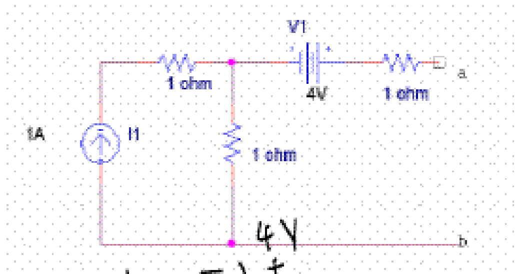


$V_1 = 12 - (1k)\,17mA = -5V$

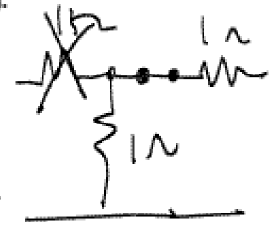
Vs(t=0⁺) = $5 - (-5) = 10\ V$

Neglect ΔV across any resistor → −5
$i_L(0^+) = 12\ mA$ → −5
$v_L(0^+) = 0$ → −5
Not having $V_s = V_2 - V_1$ → −2

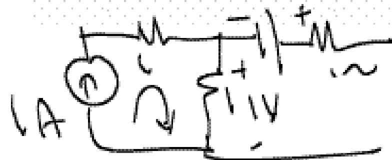
(c) Find the Norton equivalent of the circuit below at the ab terminal. (**5 points**).



Req: 2 Ω



Voc:

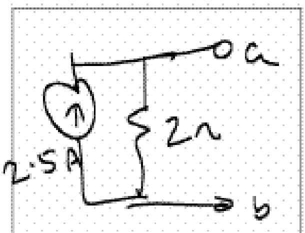


Voc = 4V + 1V = 5V

Shorting current source for Req → -2

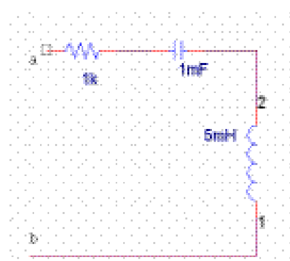
Incorrect methods → -2 (like source transform)

$V_{oc} \neq I_{sc} R_{th}$ → -2



Draw Norton Equivalent in the box

(d) In the circuit below find Z_{eq} at ab. Use ω = 1000 rad/sec (**5 points**).



$$Z = R + \frac{1}{j\omega C} + j\omega L = 1k - \frac{j}{(1000)(10^{-3})} + j(1000)(5\times10^{-3})$$

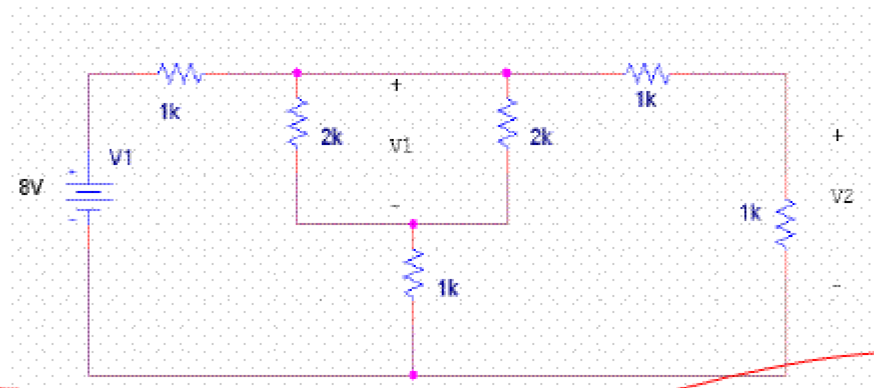
⇒ Z_{eq} = 1000 + 4j Ω

Forget -j for cap → -2

label L = 1mH → -2

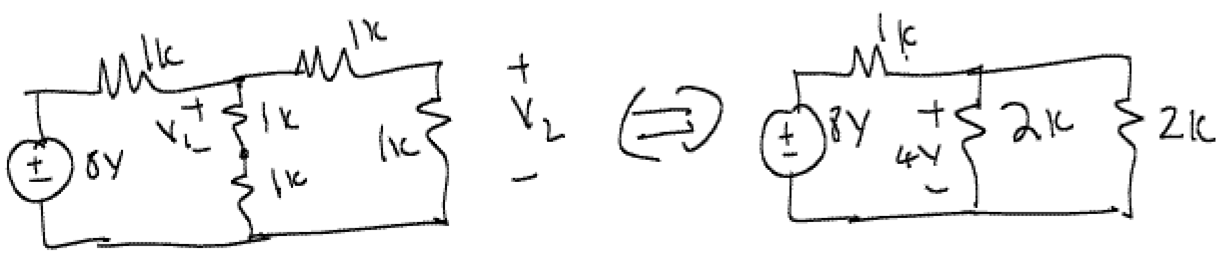
Problem 2 (30 points)

In the circuit below, find V1 and V2.



Pretty much all or −15 → most common: KCL, KVL & ohm's law errors

Use resistor reduction techniques & voltage divider.



V1 = 2V

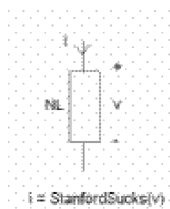
V2 = 2V

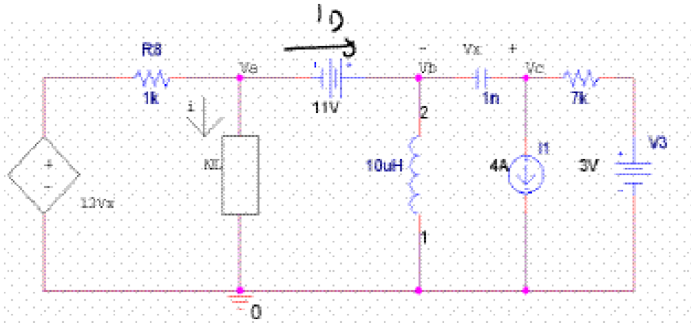
No nodal analysis → −15
AC analysis → −15
GARBAGE → −15

2 sign errors → −10
MAJOR error → −12
Dimensional inconsistency → −7
missing constraint eqn → −4
No i.c in: $i_L = \int v_L + i_0$ → −2

PROBLEM 3 (25 points)

In the circuit below, use the **NODE VOLTAGE** method to write sufficient equations to solve for the unknown node voltages Va, Vb and Vc. **DO NOT ASSUME STEADY-STATE CONDITIONS!** Your equations will obviously be in terms of the resistances, the capacitance, independent source values and the nonlinear NL element. This device has been specially made for this midterm and the I-V relationship is given below:





To receive credit, you must write your answer in the box below. **DO NOT SOLVE THE EQUATIONS!**

@ V_a: $\frac{13V_x - V_a}{1k} = \text{StanfordSucks}(V_a) + i_D$

@ V_b: $i_D = \frac{1}{10\mu H}\left[\int V_b\,dt + i_0\right] + (1nF)\frac{d}{dt}(V_b - V_c)$

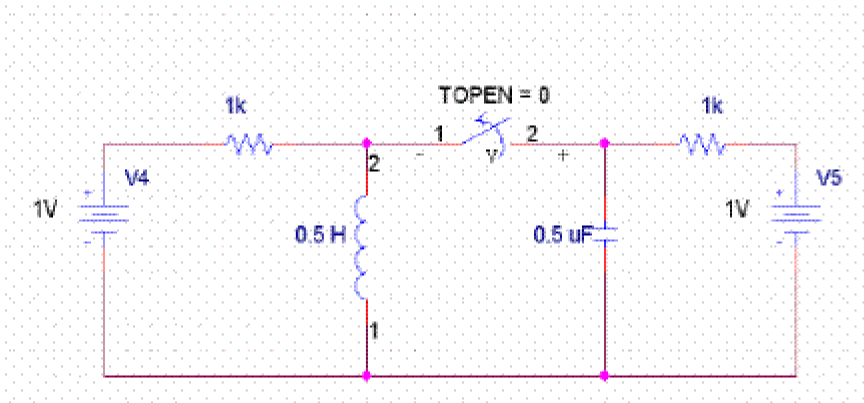
@ V_c: $1nF \frac{d}{dt}(V_b - V_c) = 4 + \frac{V_c - 3}{7k}$

Constraint (D): $V_b - V_a = 11\,V$

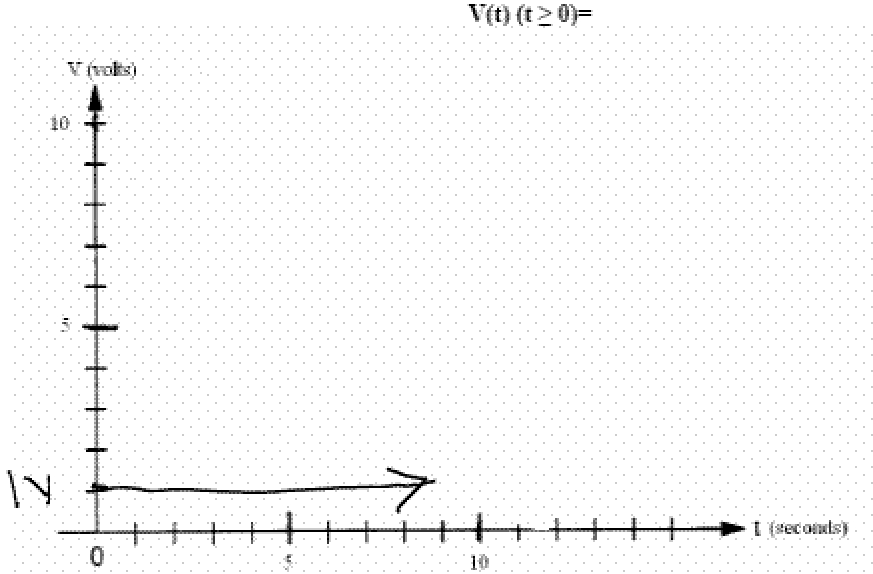
$V_c - V_b = V_x$

PROBLEM 4 (12 points)

In the circuit below, the switch has been closed for a long time before opening at t = 0. Find and Sketch V(t) for t ≥ 0.

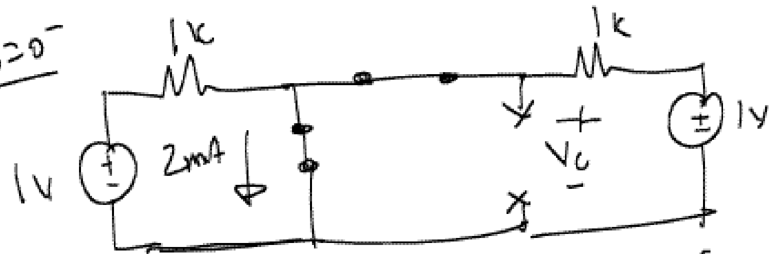


V(t) (t ≥ 0)=



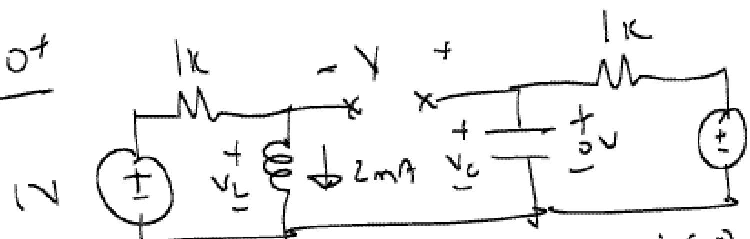
Analysis & Grading

$t=0^-$



(+3) i.c.: $\begin{cases} V_C(0^-) = 0\,V \\ i_L(0^-) = 2\,mA \end{cases}$

$t=0^+$

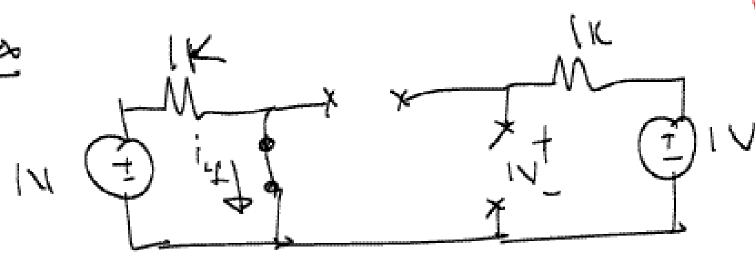


$V_c(0^-) = V_c(0^+)\ ,\ i_L(0^-) = i_L(0^+)$

$\tau_L = \frac{L}{R} = \frac{0.5H}{1k} = 0.5ms$ (+2)

$\tau_C = RC = (1k)(0.5u) = 0.5ms$

$t \to \infty$



$i_{Lf} = \frac{1V}{1k} = 1mA \qquad V_{cf} = 1V$

$$i_L(t) = i_{Lf} + (i_{Li} - i_{Lf})e^{-t/\tau_L} = 1m + (2m - 1m)e^{\frac{-t}{0.5ms}}$$

(+3) $$i_L(t) = 1 + e^{-t/0.5ms}\ mA$$

(+1) $$V_L(t) = 1V - i_L \times (1k)\ [KVL]$$

$$\Rightarrow V_L(t) = -e^{\frac{-t}{0.5ms}}\ V$$

$$v_C(t) = v_{Cf} + (v_{Ci} - v_{Cf})\, e^{-t/\tau_C}$$

+3

$$= 1 + (0-1)\, e^{-t/0.5ms} = 1 - e^{-t/0.5ms} \text{ V}$$

$$v(t) = v_C - v_L \quad [\text{KVL}]$$

$$= 1 - e^{-t/0.5m} - [1 - e^{-t/0.5m}]$$

$$= 1 \text{ V}$$