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

EE 100 — Spring 2005
Intro. To Electronics Engineering — Bharath "Bart Simpson" Muthuswamy

MIDTERM I
March 10th 2005
Time Allotted: 3 hours

NAME: Solutions, Solutions
(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. **Please note: If you are asked a numerical answer to a problem, then the answer is a whole number. If you get a decimal answer, negative answer etc. you are making a mistake! If it is a function, then it is exponential with integer coefficients and an integer exponent. If you are asked to setup equation(s) only, do NOT attempt to solve the equation(s).**

SCORE: **This page:** _____ / 3

1:_____ / 30

2:_____ / 25

3:_____ / 30

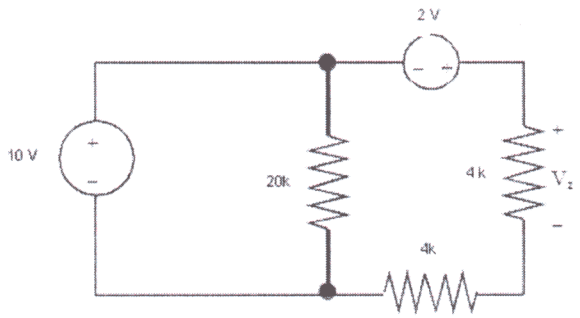
4:_____ / 12

TOTAL:_____ / 100

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_z **(5 points).**



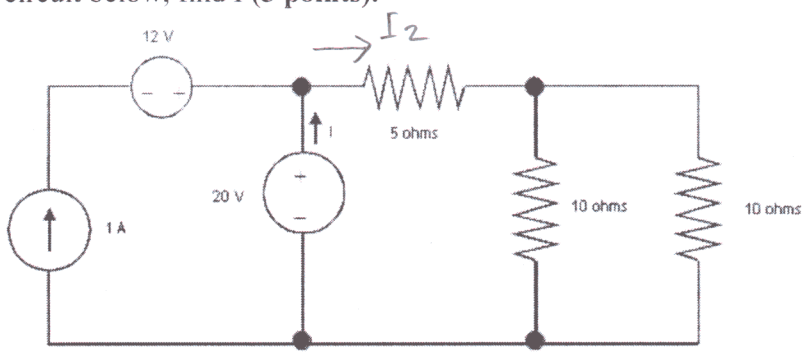
$V_z = (10+2)\frac{4k}{4k+4k}$

$= 6V$

5 → Correct
2 → little wrong
0 → totally off!

$V_z =$ 6V

(b) In the circuit below, find I **(5 points).**



5
2
0

$I_2 = \frac{20V}{5+10//10} = \frac{20V}{10\Omega} = 2A$

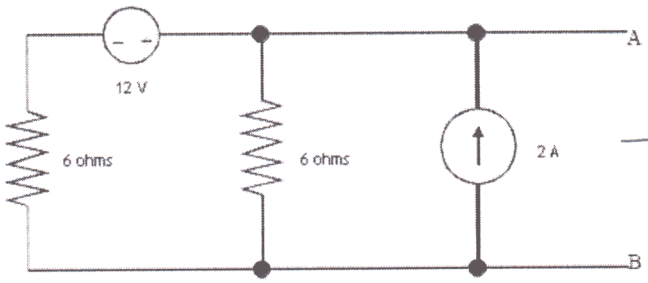
$I + 1A = I_2$

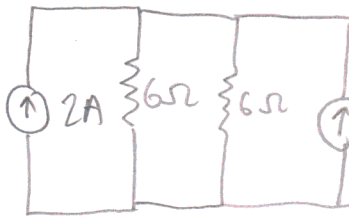
$I = I_2 - 1A$

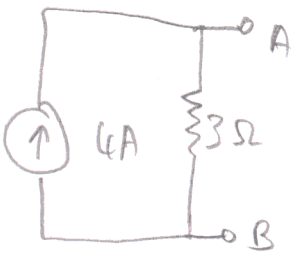
$= 1A$

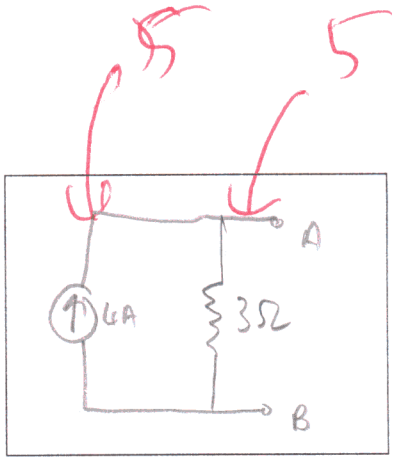
$I =$ 1A

(c) Find the Norton equivalent of the circuit below at the AB terminal. (Hint: Use source transforms to quickly solve this problem) **(10 points).**





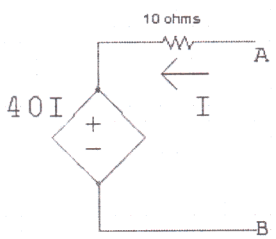




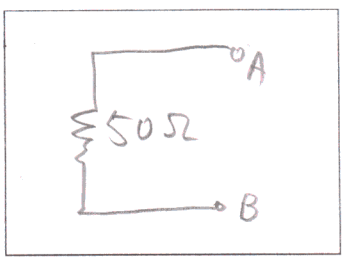
Draw Norton Equivalent in the box

(d) Find the Thevenin equivalent of the circuit below at the AB terminal **(10 points).**

V = IR
40I = IR
R = 40Ω



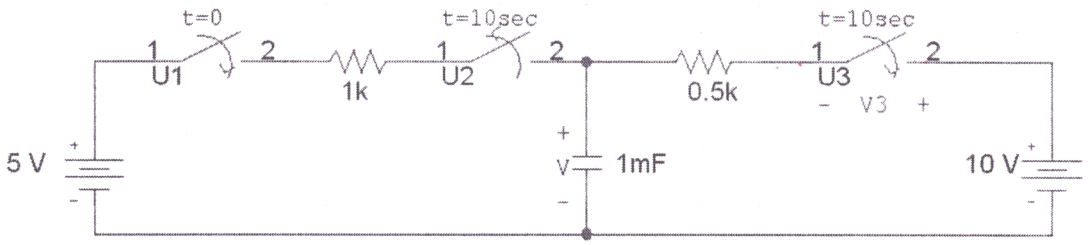
$V_{oc} \neq 0 \Rightarrow$ —b



Draw Thevenin Equivalent in the box

Problem 2 (25 points)

In the circuit below, switch U1 closes at t=0. After 10 seconds, switch U2 opens and switch U3 closes instantaneously (that is, the opening of U2 and closing of U3 occur at the same time, t = 10 sec). Assume the capacitor is uncharged at t = 0.



(a) Find V3(t=10⁻). t = 10⁻ is the instant before U2 opens and U3 closes. **(5 points)**
(b) Find V(t) for t ≥ 0 **(10 points)**
(c) On the set of axis provided, neatly sketch V(t) for t ≥ 0 **(10 points)**

$0 \le t < 10s$ $\tau = 1K \cdot 1mF = 1s$

$V_{initial} = 0V$ $V_{final} = 5V$

$V_c(t) = 5V - (5V-0V)e^{-\frac{t}{1s}}$

$= 5V - 5e^{-\frac{t}{1s}} V$

$V_c(10s) = 5V - 5e^{-10} V \approx 5V = 10V - V_3$

$V_3(t=10^-) = 5V$

V3(t=10⁻)= 5V

$t \ge 10s$

$V_{final} = 10V$ $V_{initial} = 5V$

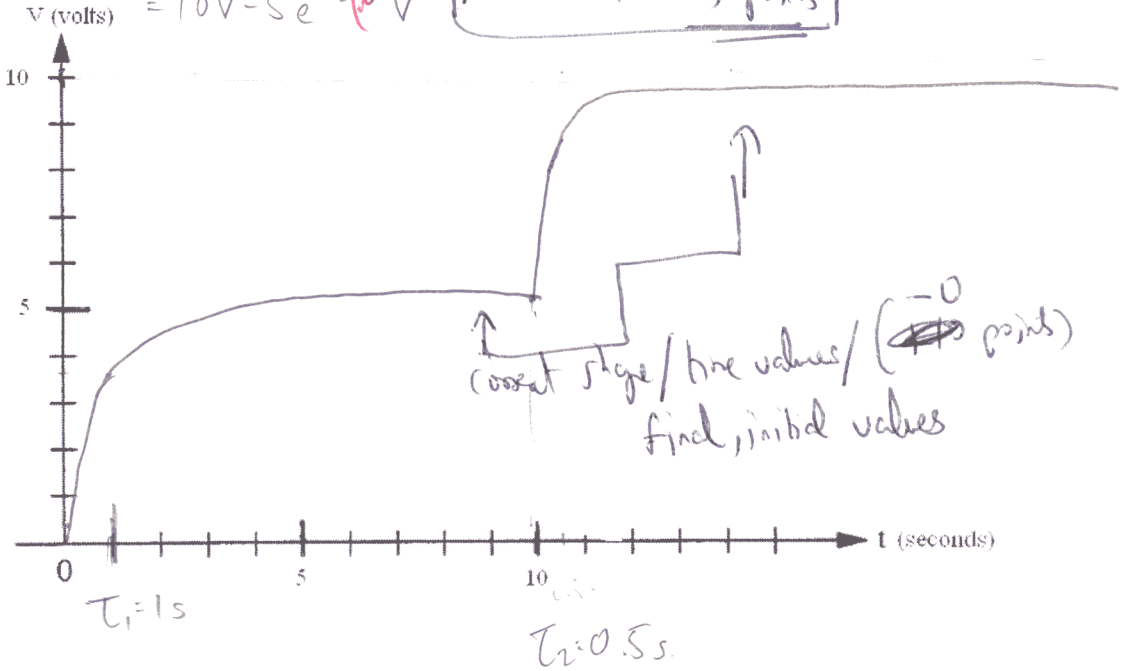
$\tau = 0.5K \cdot 1m = 0.5s$

$V_c(t) = 10V - (10V-5V)e^{-\frac{t-10}{0.5s}}$

$= 10V - 5e^{-2(\frac{t-10}{1s})} V$

V(t) (t ≥ 0)= $\begin{cases} 5 - 5e^{-\frac{t}{1s}} V & 0 \le t < 10s \\ 10 - 5e^{-2(\frac{t-10}{1s})} V & t \ge 10s \end{cases}$

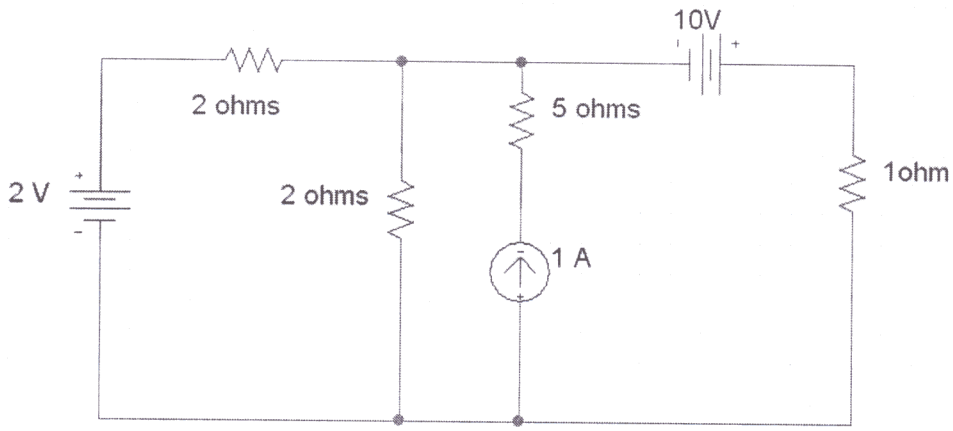
-5 points

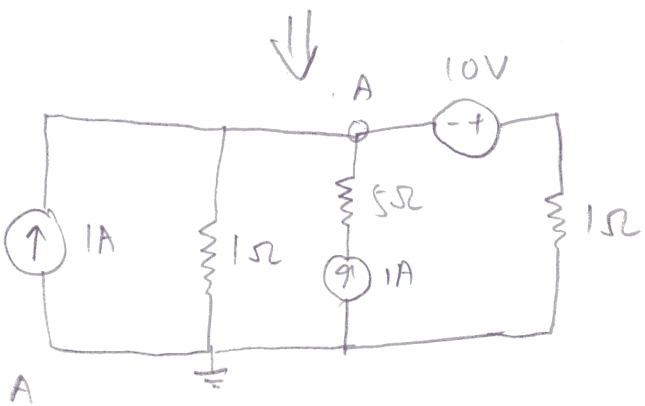


(correct shape / time values / (-0 points) find initial values

Problem 3 (30 points)

Find the power dissipated in the 1 ohm resistor





Node analysis at A

$$1A + \frac{V_A}{1\Omega} - 1A + \frac{(V_A+10)}{1\Omega} = 0$$

$$2V_A = -8\ V$$

$$V_A = -4V$$

$$V_R = V_A + 10V = 6V$$

$$P_R = \frac{V_R^2}{R} = \frac{36}{1} = 36W$$

Common mistakes

(1) Ignoring voltage drop across 1 A source (-10 points)

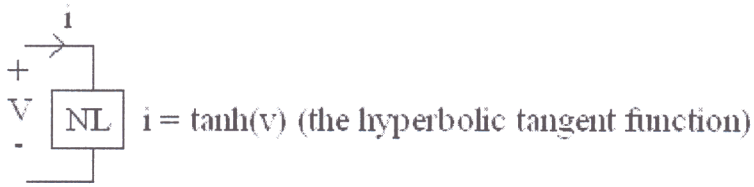
(2) Math error(s) (-5 points)

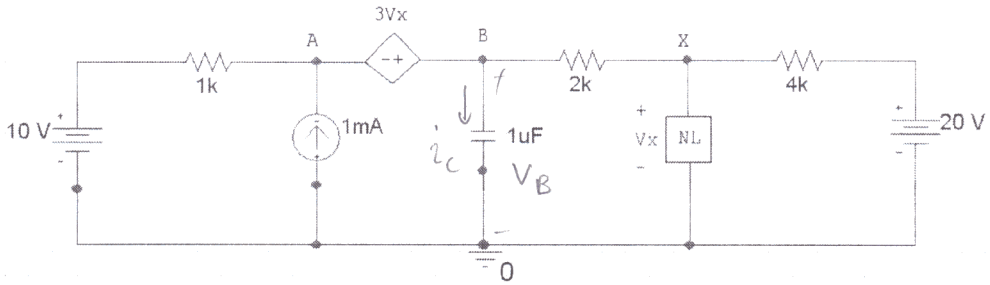
(3) Incorrect source transformation(s) / model analysis etc (-15 points)

$P_{dissipated}$ = 36W

PROBLEM 4 (12 points)

In the circuit below, use the **NODE VOLTAGE** method to write sufficient equations to solve for the unknown node voltages Va, Vb and Vx. 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!**

(1) No $i = C\frac{dv}{dt}$ => -5 points

(2) Sign errors => -7 points

(3) Totally off => -10 points

Node A, B: $\frac{V_A - 10V}{1k\Omega} - 1mA + 1\mu F\frac{dV_B}{dt} + \frac{V_B - V_x}{2k\Omega} = 0$

Node X: $\frac{V_x - V_B}{2k\Omega} + \tanh(V_x) + \frac{V_x - 20V}{4k\Omega} = 0$

Train 1: $V_B = V_A + 3V_x$

3 unknowns: V_A, V_B, V_x

3 equations. ∴ Sufficient.