

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

EE 100
Intro. To Electronics Engineering

Spring 2005
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MAKEUP MIDTERM I
March 10th 2005
Time Allotted: 3 hours

MAKEUP MIDTERM SOLUTIONS

~~NAME~~ SOLUTIONS

NAME: 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

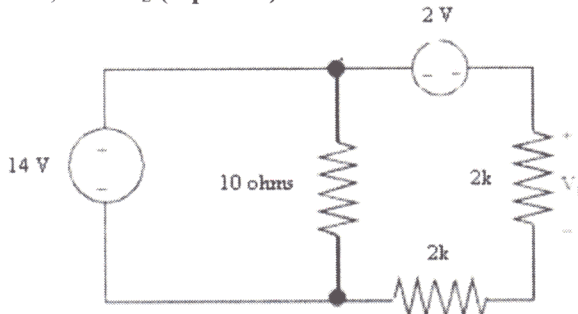
TOTAL: _____ / 100

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).

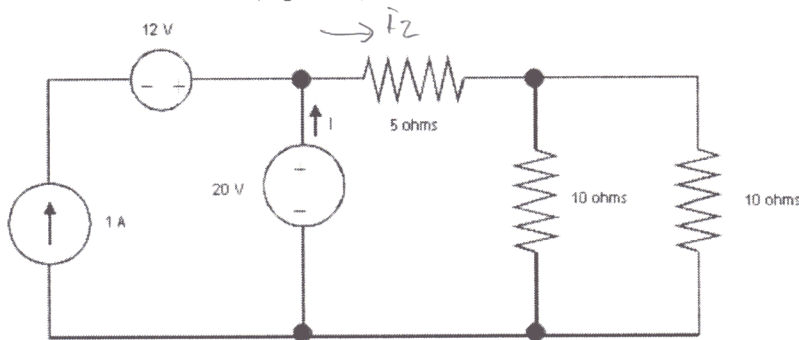
$$V_z = (14 + 2) \frac{2k}{2k + 2k} = 8V$$



5 → (solved)
2 → little work,
0

$V_z = \underline{8V}$

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



5
2
0

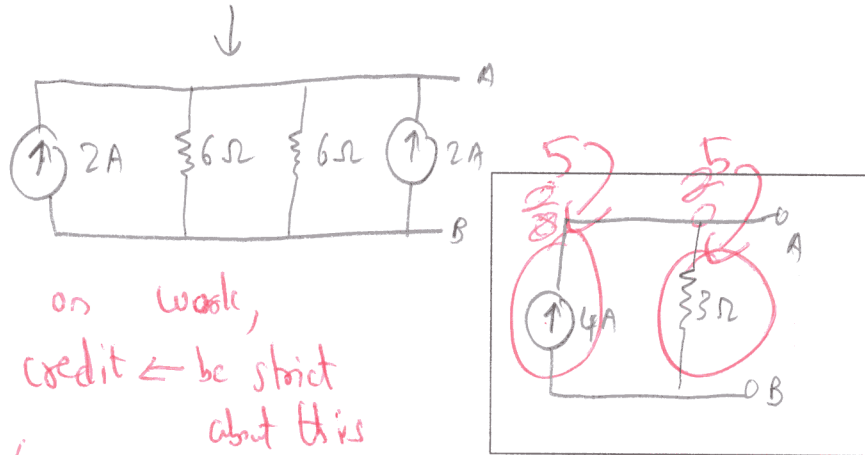
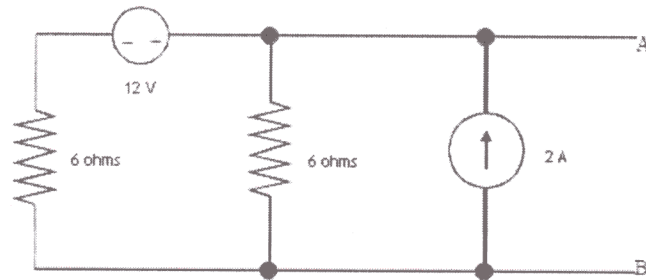
$$I_2 = \frac{20V}{5 + 10 // 10} = \frac{20V}{10\Omega} = 2A$$

$$1A + I = I_2 = 2A$$

$$I = 1A$$

$I = \underline{1A}$

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



Depending on work,
partial credit ← be strict
about this
[Since midterm is so easy]

Draw Norton Equivalent in the box

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

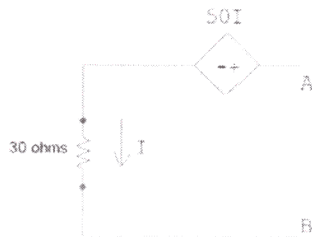
$$V = IR$$

$$50I = IR$$

$$R = 50\Omega$$

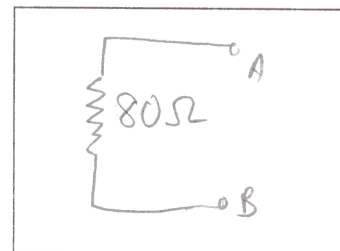
$$R_{th} = 50\Omega + 30\Omega$$

$$= 80\Omega$$



$V_{oc} \neq 0 \rightarrow 6$ points

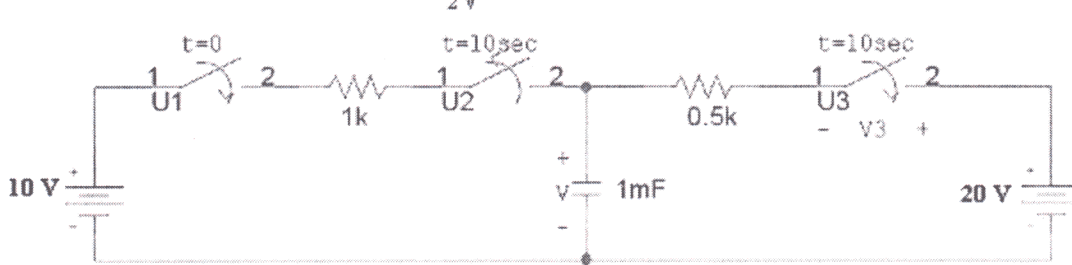
4 points



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 $V_3(t=10^-)$. $t = 10^-$ is the instant before U2 opens and U3 closes. (5 points)
 (b) Find $V(t)$ for $t \geq 0$ (10 points)
 (c) On the set of axis provided, neatly sketch $V(t)$ for $t \geq 0$ (10 points)

For $t < 10s$
 $\tau = RC = 1k\Omega \cdot 1mF = 1s$
 $V_c(t) = 10 - (10 - 0)e^{-\frac{t}{1}}$
 $= 10 - 10e^{-\frac{t}{1}} V$
 Since $\tau = 1s < 10s = 10\tau$,
 $V_c(10) \approx 10V$

For $t \geq 10s$.
 $\tau = \frac{1}{2}k \cdot 1m = 0.5s$
 $V_{initial} = 10V, V_{final} = 20V$
 $V_c(t) = 20 - (20 - 10)e^{-\frac{t-10}{0.5}}$
 $= 20 - 10e^{-\frac{t-10}{0.5}}$

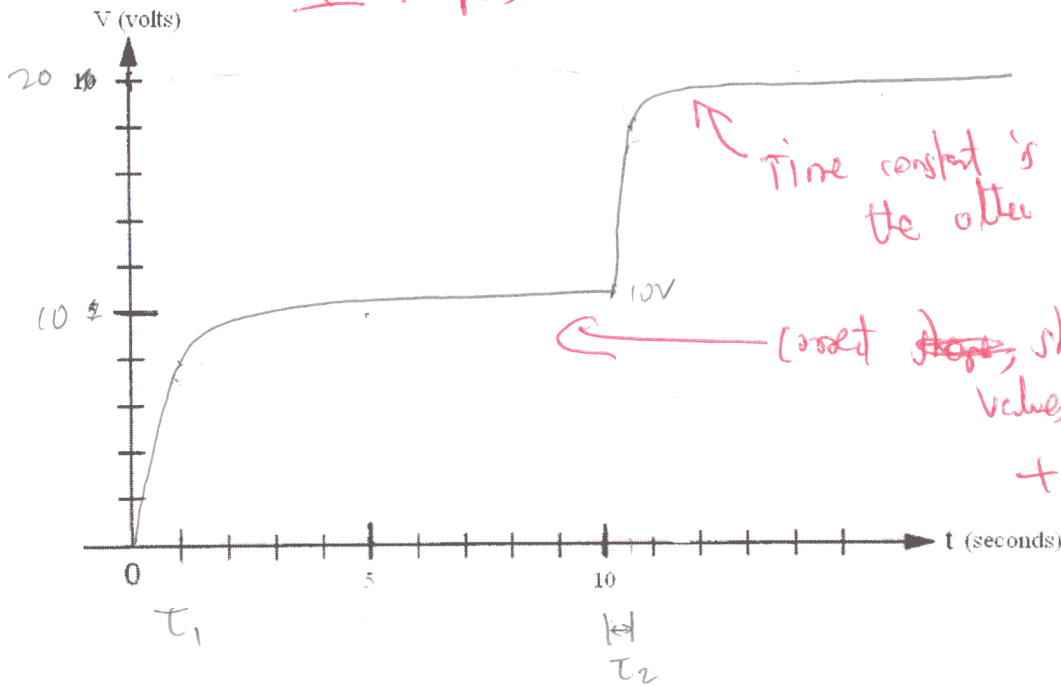
$V_3(t=10^-) = 20V - V_c(t=10^-)$
 $= 20V - 10V$
 $= 10V$

5
2
(05)
0.

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

$V(t) (t \geq 0) = \frac{10(1 - e^{-\frac{t}{1}}) V \text{ at } t < 10s}{20 - 10e^{-\frac{t-10}{0.5}} V \text{ at } t \geq 10s}$

no shift $\rightarrow -5$ plus
 rest: +5 points.

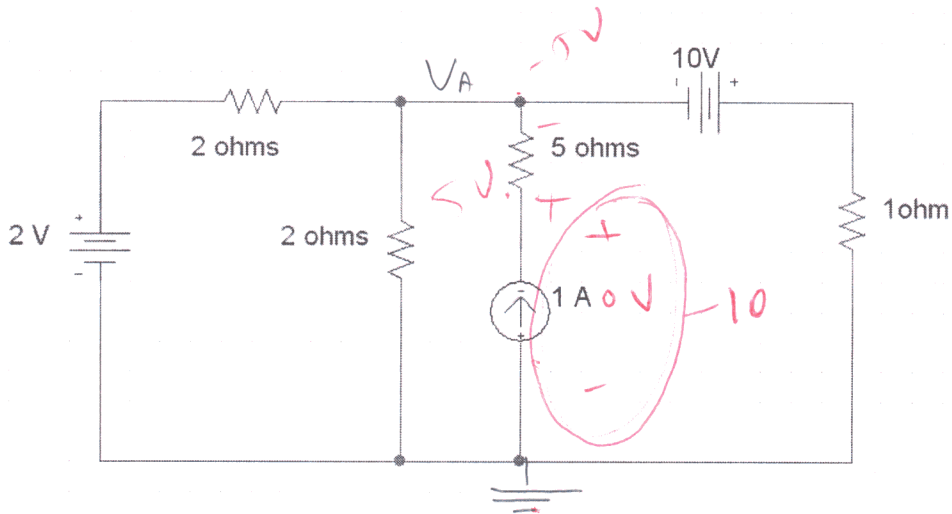


Time constant is twice the other one $\rightarrow +5$ points

Correct slope, shape, final values, initial values +5 points

Problem 3 (30 points)

Find the power dissipated in the 1 ohm resistor



KCL:

$$\frac{V_A - 2}{2} + \frac{V_A}{2} - 1A + \frac{V_A + 10}{1} = 0$$

$$V_A - 2V + V_A - 2V + 2V_A + 20V = 0$$

$$4V_A = -16V$$

$$V_A = -4V$$

$$V_R = V_A + 10 = -4 + 10 = 6V$$

$$P = \frac{V^2}{R} = \frac{6^2}{1} = 36W$$

Hard to grade,
 since students can
 use any method.
 However, be strict:

(a) ~~incorrect~~ sign convention
 inconsistent $\equiv -15$ points

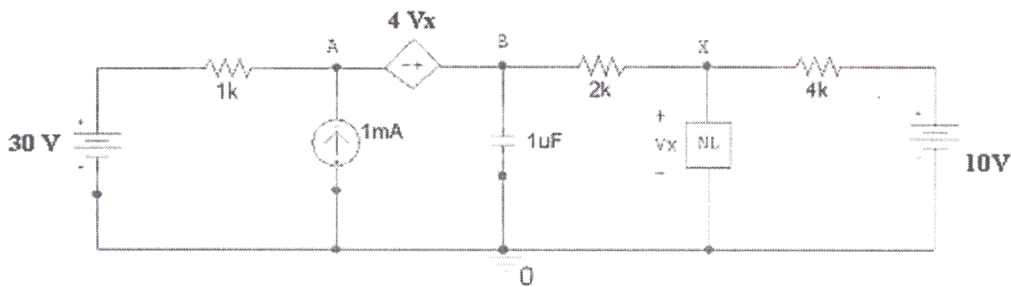
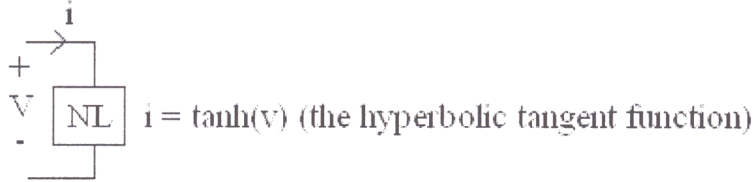
(b) ohm's law wrong
 $\equiv -15$ points
 etc

$P_{\text{dissipated}} = \underline{36W}$ ← Answer

7 +2 points

PROBLEM 4 (12 points)

In the circuit below, use the **NODE VOLTAGE** method to write sufficient equations to solve for the unknown node voltages V_a , V_b and V_x . 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!**

Bart will grade this! 😊

Supernode A, B

Node X

Constrain

$$\frac{V_A - 30V}{1k\Omega} - 1mA + 1\mu F \frac{dV_B}{dt} + \frac{V_B - V_x}{2k\Omega} = 0$$

$$\frac{V_x - V_B}{2k\Omega} + \tanh(V_x) + \frac{V_x - 10V}{4k\Omega} = 0$$

$$V_B - V_A = 4V_x$$

} No $i = c \frac{dv}{dt}$ (-5 points)
 } sign error: (-7 points)
 } totally off: (-10 points)

Unknown V_A, V_B, V_x

3 eqns