Midterm Solutions and Grading

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

EE 100/EE 42
Intro. To Electronics Engineering

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MIDTERM
July 15th 2005
Time Alotted: 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 Grader)

grade coordinator
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).

\[ V = \frac{12}{2 + 1} \cdot 5 \cdot 10^{-3} = 0 \]

(b) In the circuit below, the switch has been closed for a long time before opening at \( t = 0^- \). Find \( V_s \) at \( t = 0^- \). (10 points)

\[ i_L(t^+) = 17 \text{ mA} \]

\[ i_L(t^-) = 12 \text{ mA} \rightarrow -5 \text{ mA} \]

\[ V_L(t^-) = -5 \text{ V} \]

\[ V_{s(t^-)} = -5 \text{ V} \]

\[ V_s(t^-) = 10 \text{ V} \]

\[ V_{s(t^+)} = 10 \text{ V} \]

\[ V_s = V_L - V_1 \]

\[ V_L(t^+) = 17 \text{ mA} \rightarrow -5 \text{ mA} \]
(c) Find the Norton equivalent of the circuit below at the ab terminal. (5 points).

\[ V_{oc} = 4 \text{V} + 1 \text{V} = 5 \text{V} \]

(Incorrect method: \( V_{oc} \neq \frac{1}{2} (R_m) - 2 \))

Shorting current source for \( R_{eq} \rightarrow 2 \)

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

\[ Z = R + \frac{1}{j\omega L} = 1k + \frac{1}{(1000)(10^{-3})} + j(5 \times 10^{-3}) \]

\[ Z_{eq} = 1000 + 4j \text{ \Omega} \]

Forget \( -j \) for \( R_{eq} \rightarrow 2 \)

Label \( L = 1 \text{mH} \rightarrow -2 \)
Problem 2 (30 points)

In the circuit below, find $V_1$ and $V_2$.

Pretty much all or 10 most common: KCL, KVL & ohm's law enough.

Use resistor reduction technique & voltage divider.

\[ V_1 = \frac{2Y}{2Y} \]
\[ V_2 = \frac{2Y}{2Y} \]
PROBLEM 3 (25 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 \( V_c \). 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:

\[
V = f(V_b + V_c)
\]

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

\[
\begin{align*}
\text{at } V_a : & \quad 13V_c - V_a = \text{stand} - \text{load } (V_a) + i_D \\
\text{at } V_b : & \quad i_D = \frac{1}{19 \text{ mS}} \left[ \int V_b \, dt + i_y \right] + (\ln \tau) \frac{d}{dt} (V_b - V_c) \\
\text{at } V_c : & \quad n \tau \frac{d}{dt} (V_b - V_c) = 4 + \frac{V_c - 3}{11c} \\
\text{Constraint (ii)} : & \quad V_b - V_a = 11 \ V \\
& \quad V_c - V_b = V_c V
\end{align*}
\]
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 $t \geq 0$.

\[ V(t) \ (t \geq 0) = \]

![Diagram of an electrical circuit with V4, V5, 1k ohms, 0.5 H, 0.5 uF, and a switch labeled TOPEN = 0.]
\[ i(t) = i_f + (i_i - i_f)e^{-t/\tau_c} = 1mA + (2mA - 1mA)e^{-t/0.5 \text{ms}} \]

\[ i_L(t) = 1 + e^{-t/0.5 \text{ms}} \text{mA} \]

\[ v_L(t) = 1V - i_L(t) \times (1k) \left[ \frac{1}{s} \right]e^{-t/0.5 \text{ms}} \]

\[ v_c(t) = -e^{-t/0.5 \text{ms}} \text{V} \]
\[ v_{CBD} = v_C + (v_{ci} - v_{cf}) e^{-t/\tau_C} \]

\[ = 1 + (0-1)e^{-t/0.5s} = 1 - e^{-t/0.5s} \]

\[ v_{BG} = v_C - v_L [kUL] \]

\[ = 1 - e^{+t/0.5s} - [e^{-t/0.5s}] \]

\[ = 1 \]