MIDTERM I
March 10th 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. 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).

$$V_z = \frac{(10+2)}{\frac{4k}{4k+4k}}$$
$$V_z = 6V$$

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

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

$$I_1 + 1A = I_2$$
$$I = I_2 - 1A$$
$$I = 1A$$

$V_z = 6V$
(c) Find the Norton equivalent of the circuit below at the AB terminal. (Hint: Use source transforms to quickly solve this problem) (10 points).

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

\[ V_3(t=10') = \frac{5V}{10'} \]

\[ V(t) \ (t \geq 0) = \begin{cases} \frac{-5}{10''}V & 0 < t < 10'' \\ 0 & \text{otherwise} \end{cases} \]
Problem 3 (30 points)

Find the power dissipated in the 1 ohm resistor

Node analysis at A

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

2 \( V_A = -8 \) V

\( V_A = -4 \) V

\( V_R = V_A + 10 \) V = 6 V

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

Common mistakes:

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

2. Math errors (-5 points)

3. Incorrect source transformation (i.e., analysis etc) (-15 points)

\[ P_{\text{dissipated}} = 36 \text{ W} \]
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:

$$i = \tanh(v) \text{ (the hyperbolic tangent function)}$$

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

1. $\text{Node A, B:}$
   - $V_a - 10V - 1mA + 1 \mu F \frac{dV_b}{dt} + \frac{V_b - V_x}{2kΩ} = 0$
   - $\frac{V_x - V_b}{2kΩ} + \tanh(V_x) + \frac{V_x - 20V}{4kΩ} = 0$
   - $V_b = V_a + 3V_x$

   **3 unknowns: $V_a$, $V_b$, $V_x$**
   **3 equations. Sufficient.**