Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.002 – Circuits and Electronics
Spring 2003

Handout S03-048 - Quiz # 2

Thursday April 9, 2003

Name: _____

Recitation Instructor (circle one):

Baldo Hutchinson Kolodziejski Schindall Wilson

Recitation Hour (circle one):

9 10 11 12 1 2

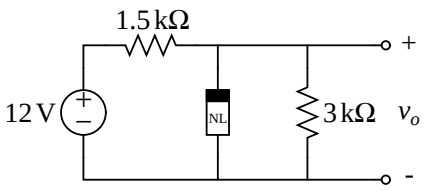
ALL PROBLEMS CARRY THE SAME WEIGHT

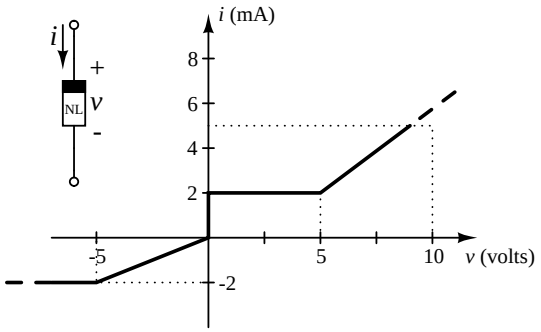
Problem	Points	Score	Grader
1	25		
2	25		
3	25		
4	25		
Total	100		

Name:_____

PROBLEM 1

The circuit below contains a nonlinear element whose iv characteristics are shown.





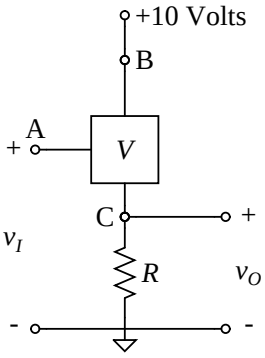
(A) Determine the voltage v_O graphically - show your construction.

(B) Can this circuit be described by a Thevenin equivalent circuit at the terminals? Explain!

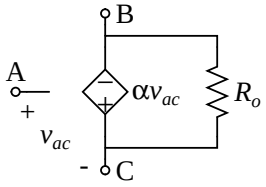
Name:_____

PROBLEM 2

This circuit uses a control valve V which has the small-signal model shown.



Small-Signal Model of V



Assume that the static component of v_I establishes a suitable operating point at which the small-signal model applies.

(A) Sketch and label a small-signal model of the circuit which can be used to calculate the small-signal voltage gain $A_v = \frac{v_o}{v_i}$ where v_o and v_i are the small-signal components of v_O and v_I.

Name:_____

(B) Express v_{ac} in terms of v_i and v_o.

For Extra Credit: (one-third the value of a problem)

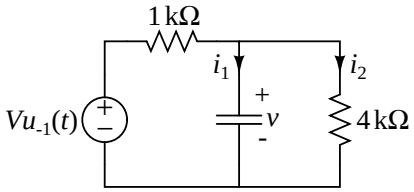
(C) Derive an expression for $A_v = \frac{v_o}{v_i}$, the incremental voltage gain.

Name:_____

PROBLEM 3

For each of the circuits below, determine the initial and final (asymptotic) values of the indicated variables.

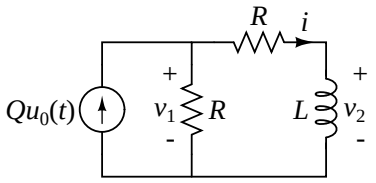
(A)



For $t<0$, $v=0$
v is in Volts

VARIABLE	$t = 0^+$	$t \to \infty$	UNITS
v			
i_1			
i_2			

(B)



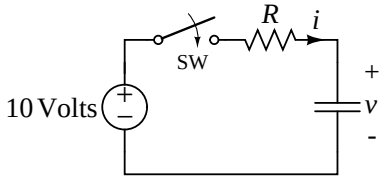
For $t<0$, $i=-I$
Q is in Coulombs
R is in Ohms
I is in Amps

VARIABLE	$t = 0^+$	$t \to \infty$
i		
v_1		
v_2		

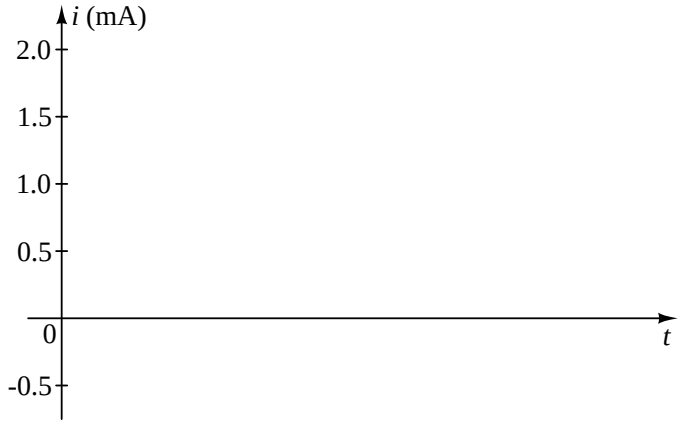
Name:_____

PROBLEM 4

The capacitor in the circuit below is initially charged to the voltage $v = -5$ Volts. At $t = 0$ the switch closes.



$v = -5$ V for $t < 0$
$R = 10\,\text{k}\Omega = 10^4\Omega$
$C = 1\ \mu\text{F} = 10^{-6}\text{F}$



(A) Without detailed analysis of the circuit, sketch $v(t)$ and $i(t)$ for $t > 0$. Label initial values and asymptotes.

(B) Determine the time constant with which the circuit responds.

(C) Express either $v(t)$ or $i(t)$ as a function of time. If you can do this without first developing an analytical solution, fine.

Name:_____

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