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Department of Electrical Engineering and Computer Science

ENGR 210. Introduction to Circuits and Instruments (4)

ENGR 210 - SPRING 2005

FINAL EXAMINATION–5/3/05

		Possible	
1.		10	DC circuit analysis
2.		10	Controlled sources
3.		10	Multiple OP AMP circuits
4.		10	Computer interfacing
5.		10	Thevenin/Norton
6.		10	Capacitors and Inductors
7.		10	Phasors
8.		10	Frequency response
9.		10	First order circuits
10.		10	Switched transients
SCORE		100	

ACADEMIC DISHONESTY

All forms of academic dishonesty including cheating, plagiarism, misrepresentation, and obstruction are violations of academic integrity standards. Cheating includes copying from another's work, falsifying problem solutions, or using unauthorized sources, notes or computer programs. Misrepresentation includes forgery of official academic documents, the presentation of altered or falsified documents or testimony to a university office or official, taking an exam for another student, or lying about personal circumstances to postpone tests or assignments. Obstruction occurs when a student engages in unreasonable conduct that interferes with another's ability to conduct scholarly activity.

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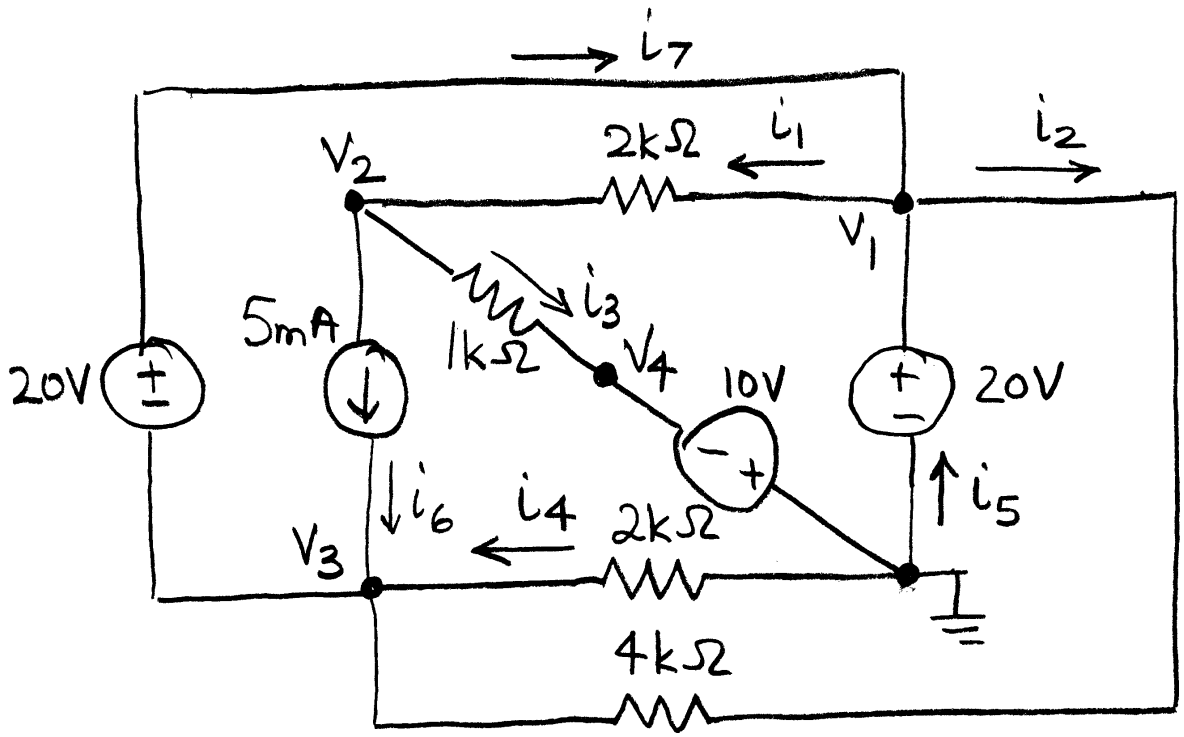
Problem 1 DC Circuit Analysis (10 points)
Determine the indicated node voltages (with respect to ground) and currents for the circuit shown below. All voltages are to be in volts and all currents in amperes.



v_1= _____ i_1= _____ i_5= _____
v_2= _____ i_2= _____ i_6= _____
v_3= _____ i_3= _____ i_7= _____
v_4= _____ i_4= _____

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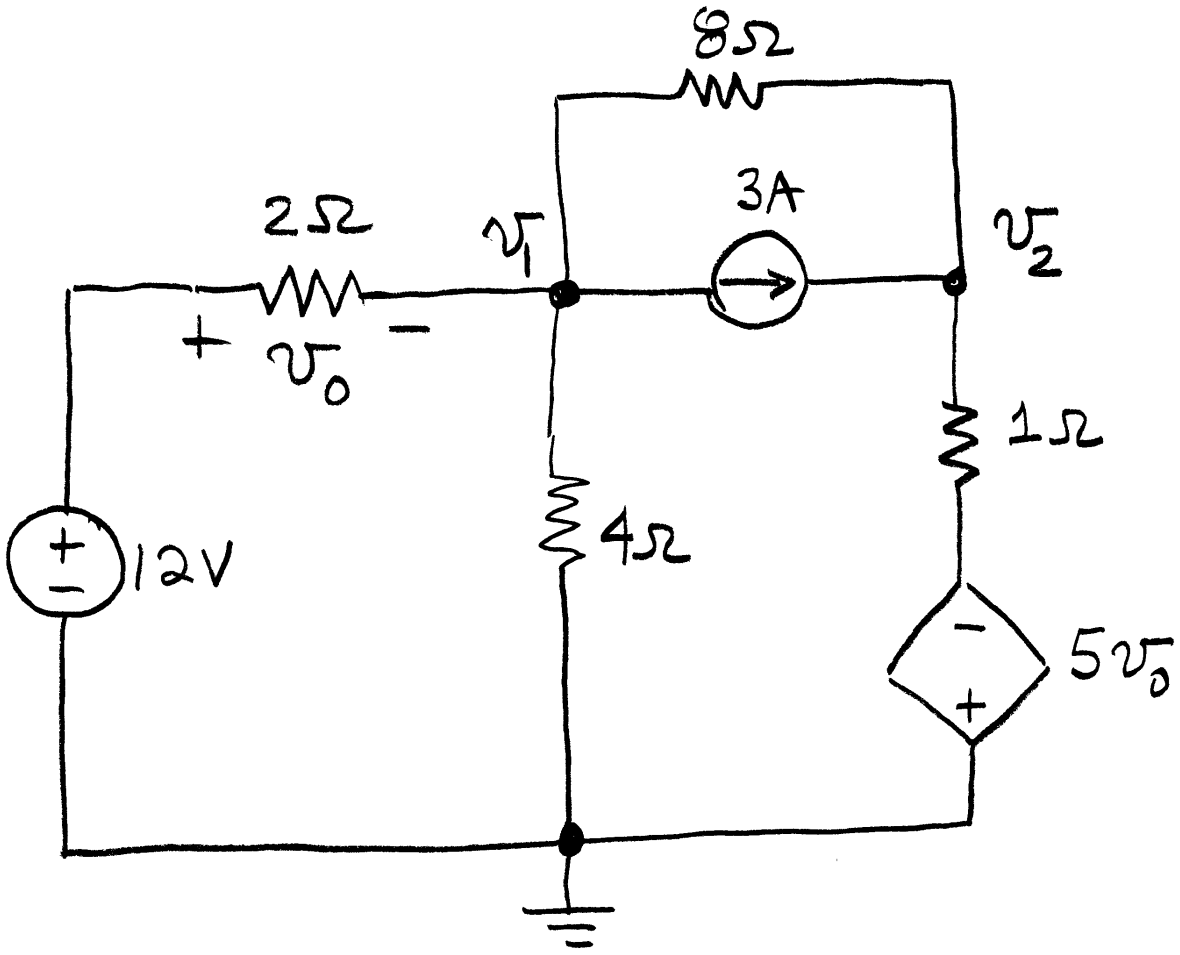
Problem 2 Circuits with controlled sources (10 points)

Find the node voltages v_1 and v_2 for the circuit shown below..

v_1= _____ v_2= _____



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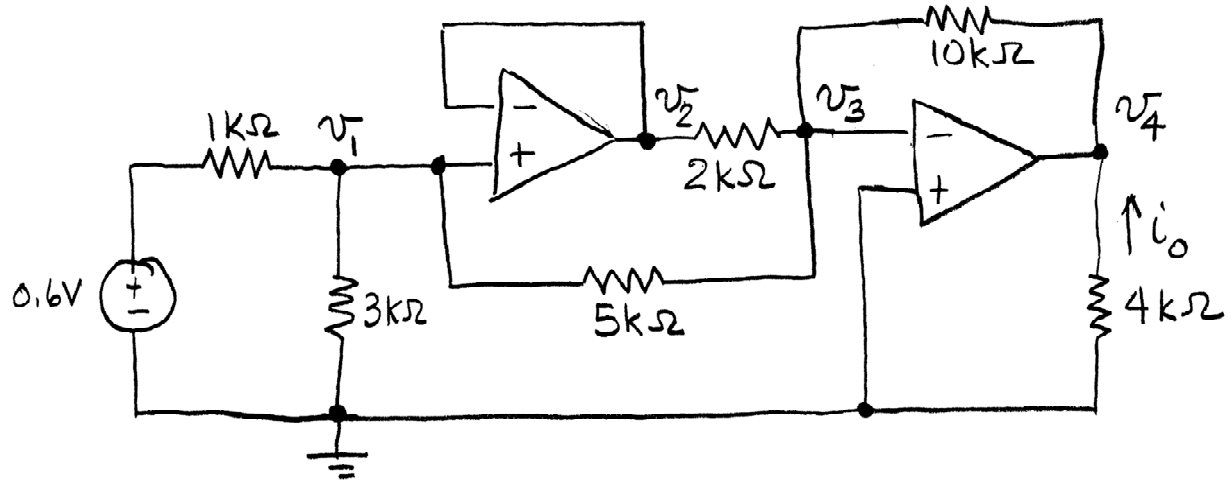
Problem 3 Multiple Op Amp Circuits (10 points)
Determine the indicated node voltages (with respect to ground) and currents for the circuit shown below. All voltages are to be in volts and all currents in amperes.



v_1= _____ v_3= _____ i_o= _____
v_2= _____ v_4= _____

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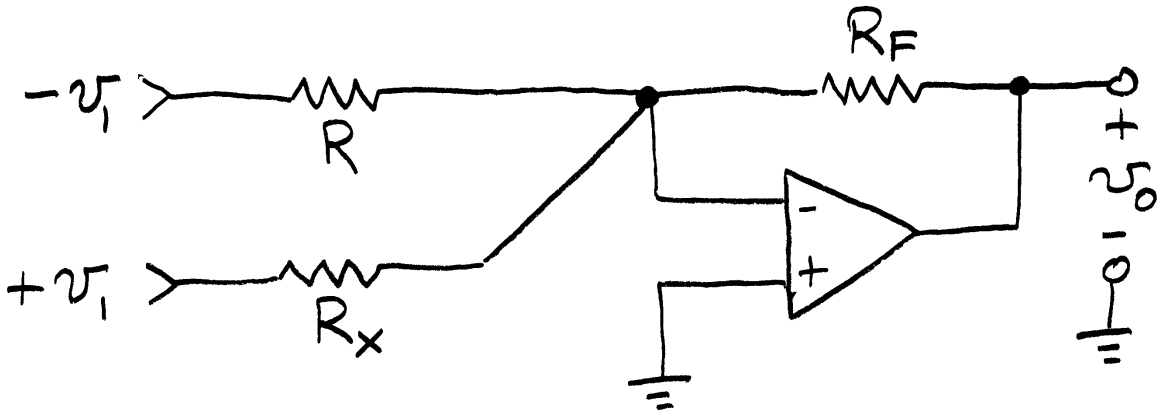
Problem 4 Computer Interfacing (10 points)

The resistance Rx of a semiconductor pressure sensor varies linearly with pressure from 5kΩ (0 psi) to 15kΩ (100 psi). This sensor is placed in the following circuit.



(a) Determine $\frac{v_o}{v_1}$ for the above circuit.

(b) For v_1=15 volts, select values of R and R_F to convert the sensor resistance to a voltage output which ranges from 0 to 5 volts.

(c) Is the output voltage from your circuit a <u>linear</u> function of pressure?

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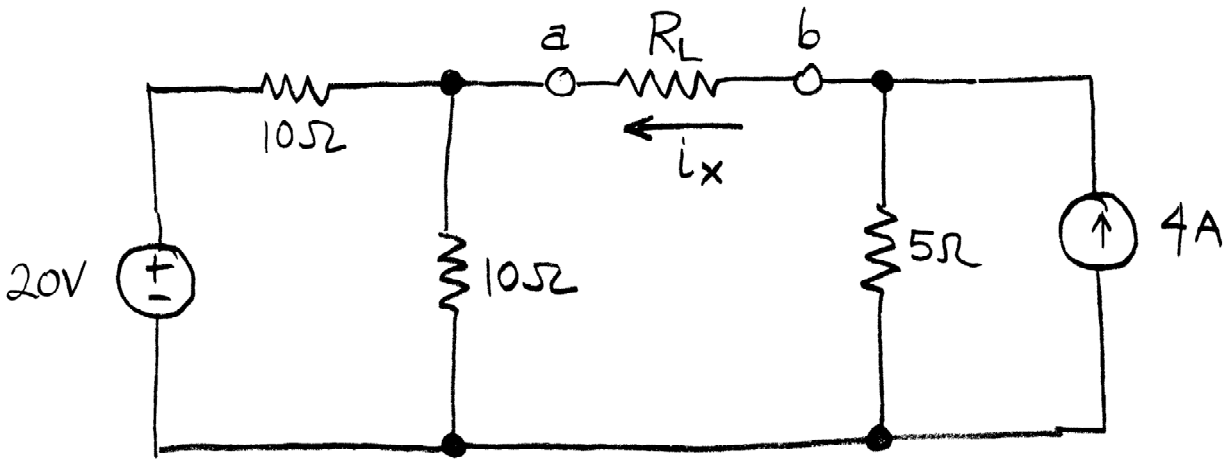
Problem 5 Thevenin and Norton Equivalent Circuits (10 points)



Answer the following questions about this circuit.

(a) What is the open circuit voltage V_{OC}, i.e., if $R_L=\infty$? _____

(b) What is the Thevenin equivalent resistance of this circuit as seen by R_L? _____

(c) What is the short circuit current i_{SC}, i.e., if $R_L=0$? _____

(d) What is the current i_x when the load resistance R_L between a and b is 6Ω.

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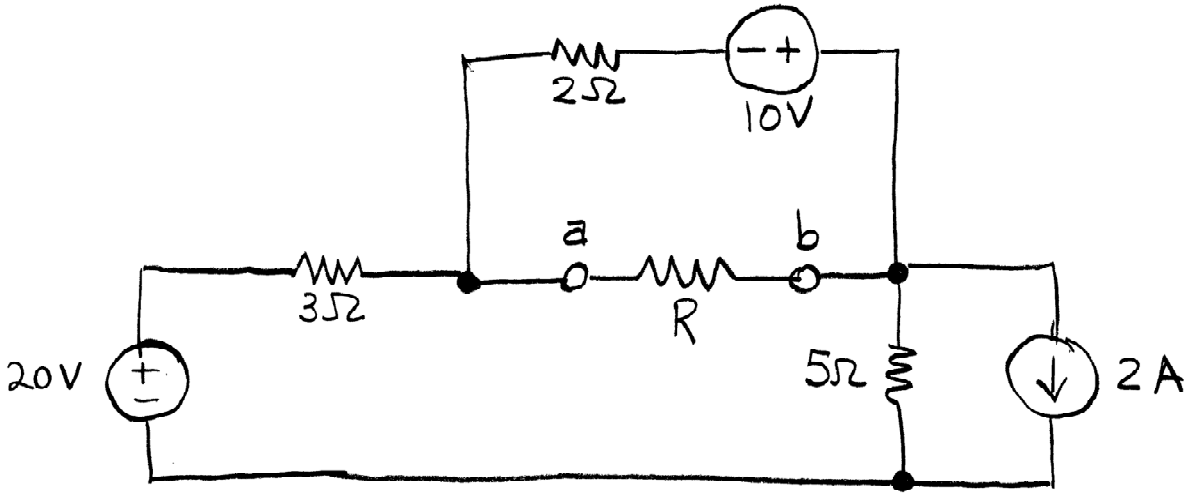
Problem 5 Thevenin and Norton Equivalent Circuits (10 points)



(a) What is the Thevenin equivalent of the circuit as seen by resistor R at terminals a-b.

V_T=_____ R_T=_____

(b) What is the maximum power that can be dissipated in R?

Power=_____

(b) What is the value of R which gives this maximum power dissipation?

R=_____

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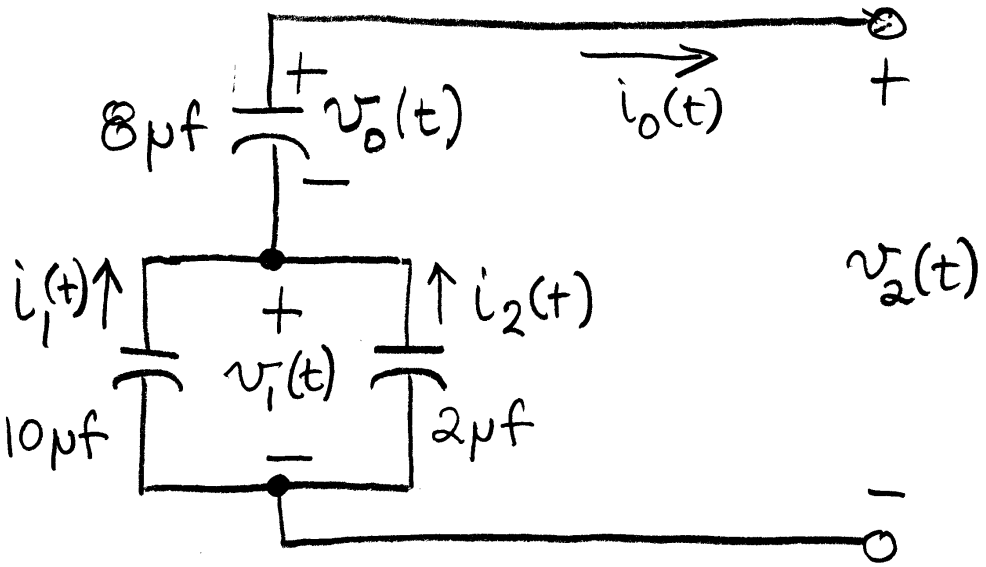
Problem 6 Capacitors and Inductors (10 points)

Consider the capacitor circuit shown below. The current is $i_0(t) = 1.92e^{-20t}$ milliamperes for t≥0. The initial conditions are $v_o(0) = -5$ volts and $v_1(0) = +25$ volts.



a) What is $v_0(t)$ for t≥0?

b) What is $v_1(t)$ for t≥0?

c) What is $i_1(t)$ for t≥0?

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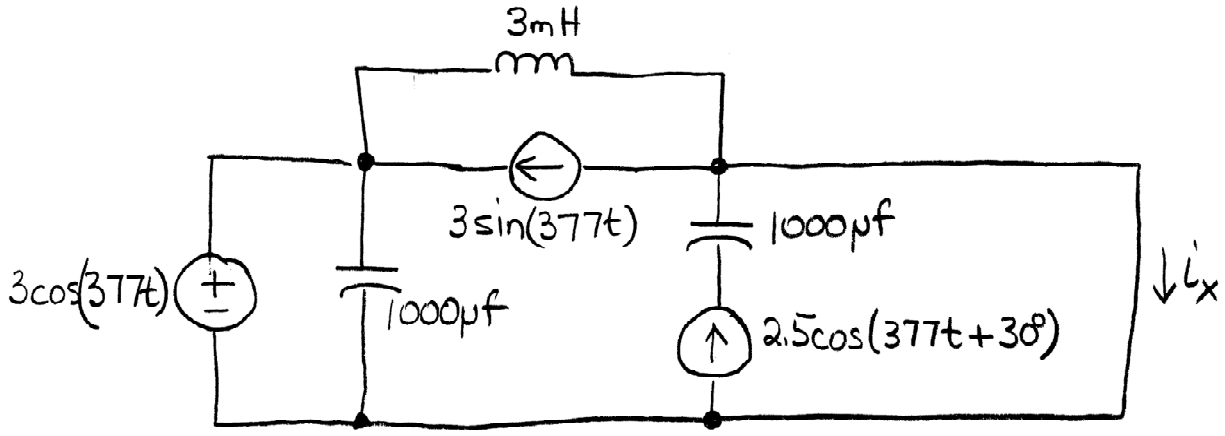
Problem 7 Phasors (10 points)



(a) What is the frequency f in Hertz at which this circuit is operating? f=_____

(b) Transform each source to its phasor equivalent

3cos(377t) → _____

3sin(377t) → _____

2.5cos(377t+30°) → _____

(c) Transform each component to its equivalent impedance.

3 mH → _____

1000 μf → _____

(d) Redraw the above circuit as an equivalent phasor circuit.

(e) Find the phasor current $\underline{i}_x$.

(f) What is $i_x(t)$?

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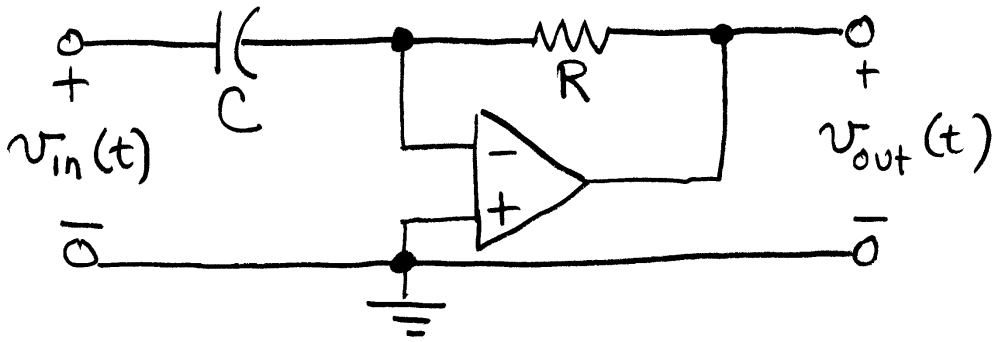
Problem 8 Frequency response (10 points)
Consider the circuit shown below where $v_{in}(t) = 5\cos 1000t$ volts, R=10kΩ, and C=0.1μf.

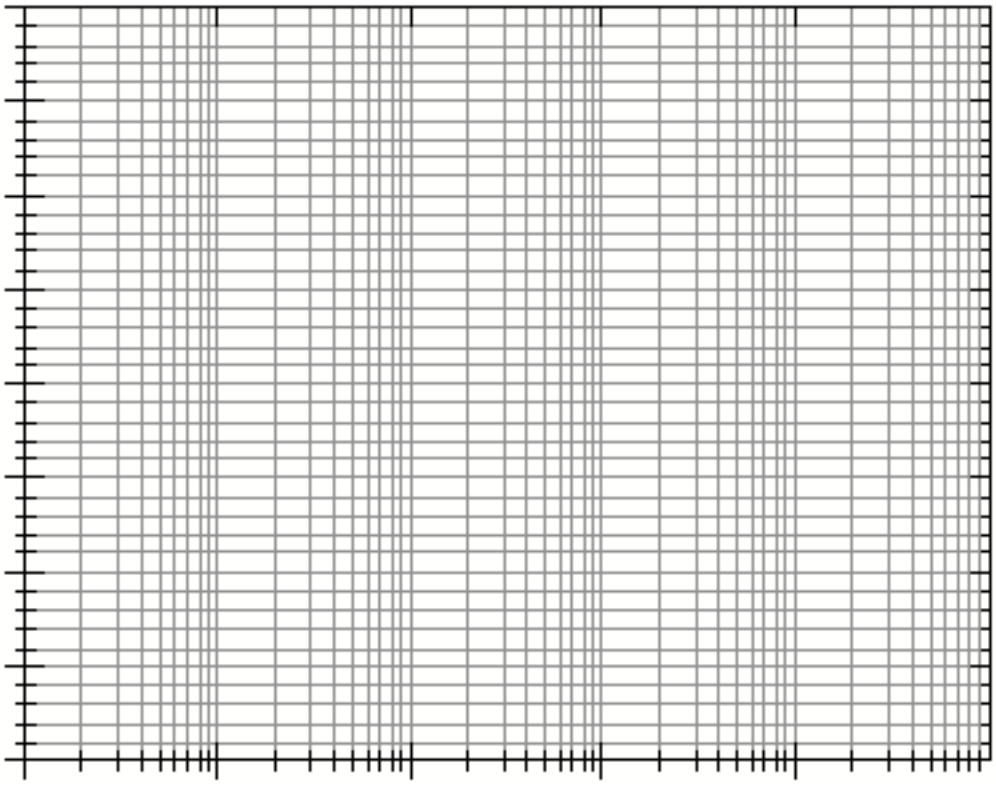


(a) Write the expression for the output in the time domain. $v_{out}(t)$ = _____

(b) Convert the circuit elements to phasors and evaluate the expression

$$T(j\omega) = \frac{v_{out}(j\omega)}{v_{in}(j\omega)} = \_\_\_\_\_$$

(c) Sketch $|T(j\omega)|$ for $10 < \omega < 10000$ radians/second. Label your axes.



(d) What kind of filter is this?

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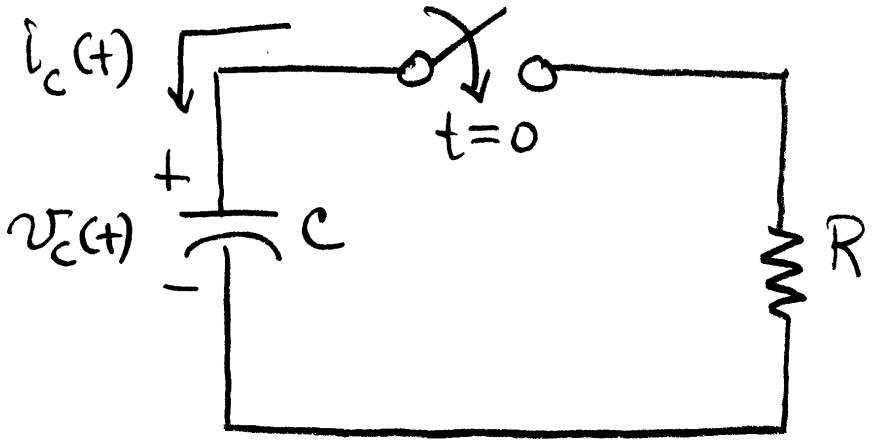
Problem 9 Electrical Transients (10 points)

An airbag deploys when a pendulum switch detects a sudden deceleration greater than 10g and closes a switch. A simple equivalent circuit of the airbag deployment device is shown below. You are given that $v_c(0) = 24$ volts, R=100Ω, and C=0.1mf.



a) Determine $v_c(t)$ for t≥0.

b) Determine an equation for the energy dissipated in the resistor as a function of time.

c) The airbag will deploy when the energy absorbed by the resistor (in reality a fuse) reaches 25 mJ. How low it will take for the air bag to deploy after the switch closes?

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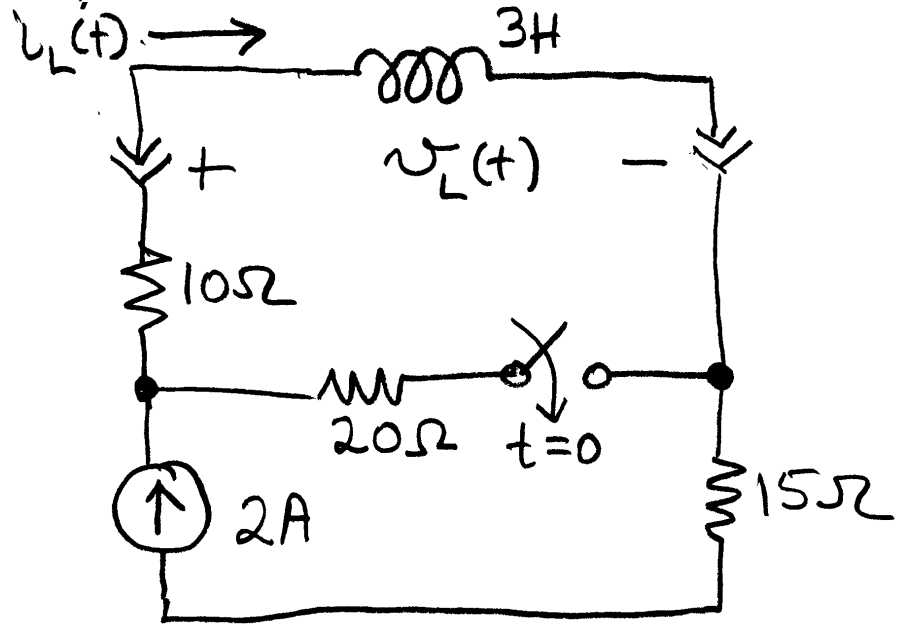
Problem 10 Switched circuits (10 points)
The switch in the circuit shown below has been open for a long time and the circuit is in steady state. At t=0 the switch closes.



(a) What is the initial value of i_L , i.e., $i_L(0)$?

(b) What is the final value of i_L , i.e., $i_L(\infty)$?

(c) What is the time constant of this circuit for $t \geq 0$?

(d) Write the expression for $i_L(t)$ for $t \geq 0$.

(e) What part of (d) is the forced response?

(f) What part of (d) is the natural response?

(g) What is the state variable for this circuit?