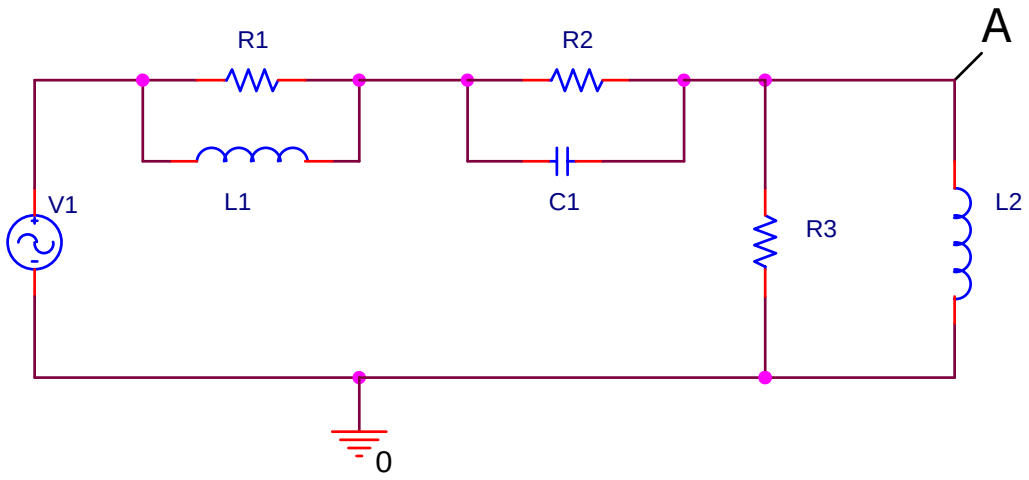
Questions on Inductance and Capacitance
These questions will help prepare you for question 2 of quiz 1.

Fall 2004
4. Inductors and Capacitors at High and Low Frequency (25 points)

The following circuit is created in Pspice:



The components in the circuit have the following values: R1=1K, R2=2K, R3=1K, L1=10mH, L2=30mH, and C1=0.1μf. The amplitude of the input voltage, V1, is 100mV.

a) Redraw the circuit at very low frequencies. *(3 points)*

b) Redraw the circuit at very high frequencies. *(3 points)*

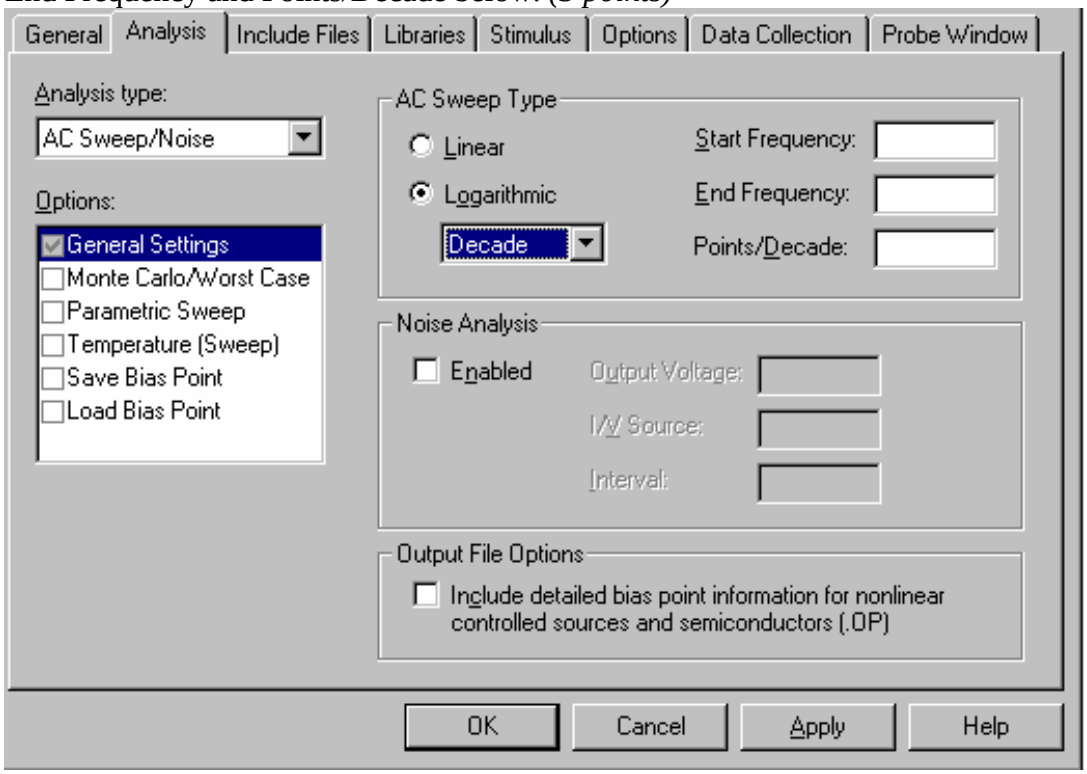
c) Assuming the values given for the circuit, what would be the amplitude of the output voltage (point A) at very low frequencies? *(3 points)*

d) Assuming the values given for the circuit, what would be the amplitude of the output voltage (point A) at very high frequencies? *(3 points)*

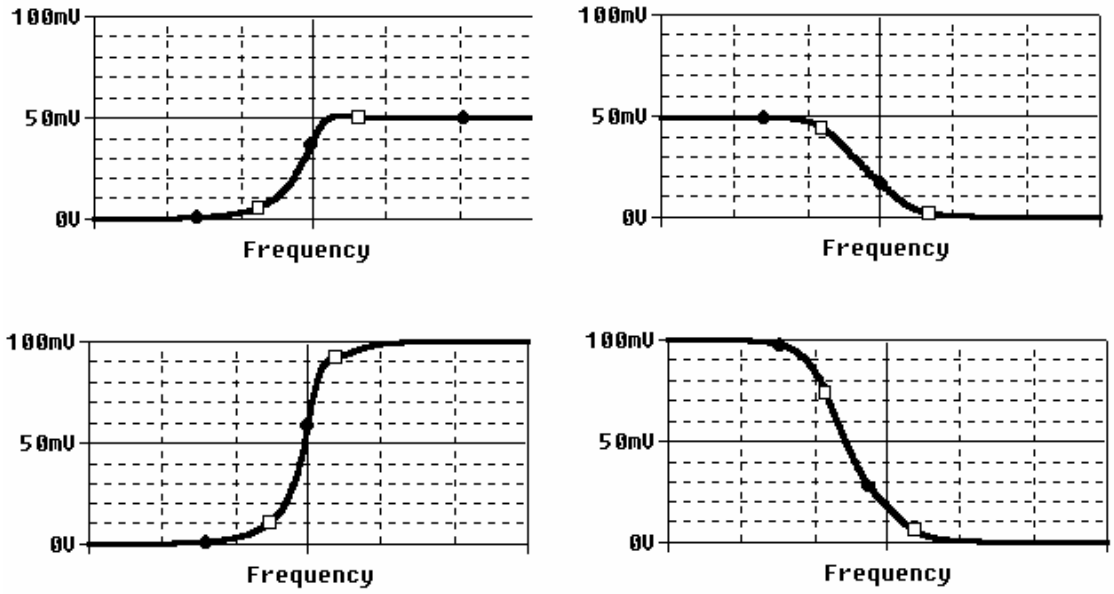
e) Describe how you would set up this input signal with a 1K hertz frequency on the function generator. Give specific details. *(4 points)*

f) Describe how you would use the ‘scope to generate a Lissijous pattern which compares the input signal to the output signal at point A. Give specific details. *(4 points)*

g) You would like to set up an AC sweep in Pspice to see the response of the above circuit at low and high frequencies Please enter reasonable values for the Start Frequency, End Frequency and Points/Decade below. *(3 points)*



h) Circle the output below that looks most like the sweep you would see for the circuit in this question. *(2 points)*



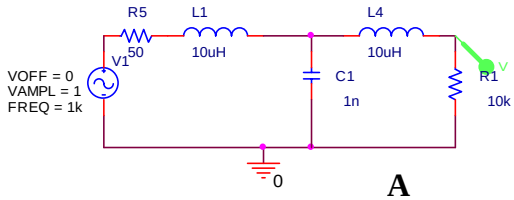
Fall 2004 solution

(not available)

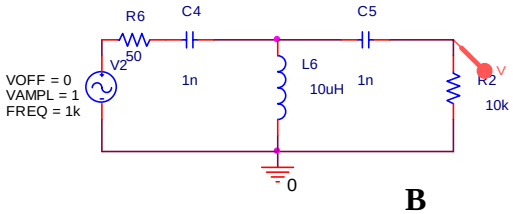
Spring 2004

3) Circuits at Low and High Frequencies (24 points)

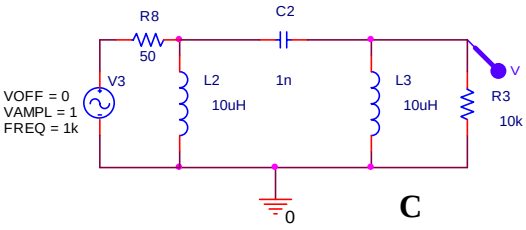
The following four circuits are analyzed using PSpice:



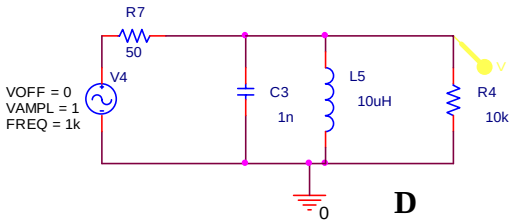
A



B



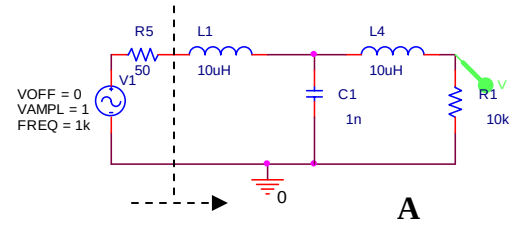
C



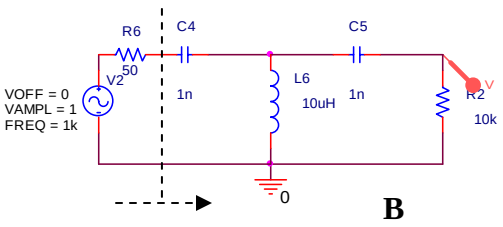
D

a. Simplify each circuit at DC (very low) frequencies by replacing the inductors and capacitors with short or open circuits, as appropriate. *(8 points)*

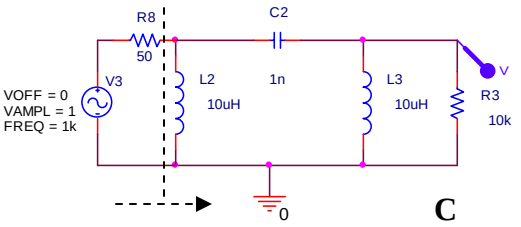
b. Simplify each circuit at very, very high frequencies by replacing the inductors and capacitors with short or open circuits, as appropriate. *(8 points)*



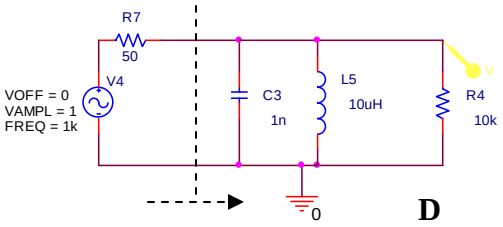
A



B

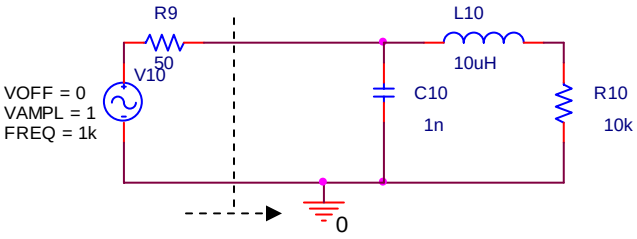


C



D

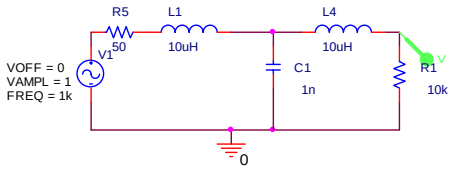
c. For each circuit, what resistance would be measured to the right of the dashed line at DC (very low) and very, very high frequencies? For example, for the following circuit, the resistance measured to the right of the dashed line would be 10k at DC and zero at very, very high frequencies. *(8 points :1 point each for low, 1 point each for high)*



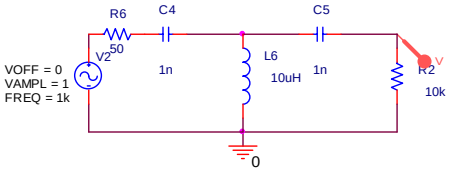
Spring 2004 solution

3) Circuits at Low and High Frequencies (24 points) [Both A and B]

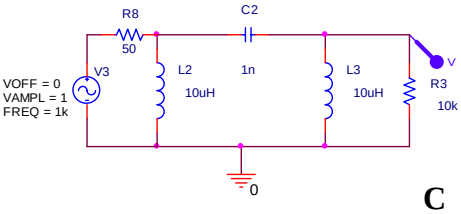
The following four circuits are analyzed using PSpice:



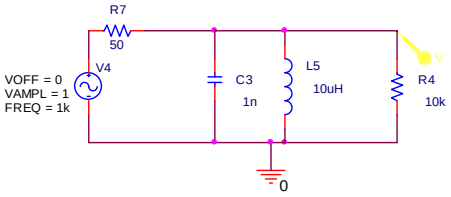
A



B

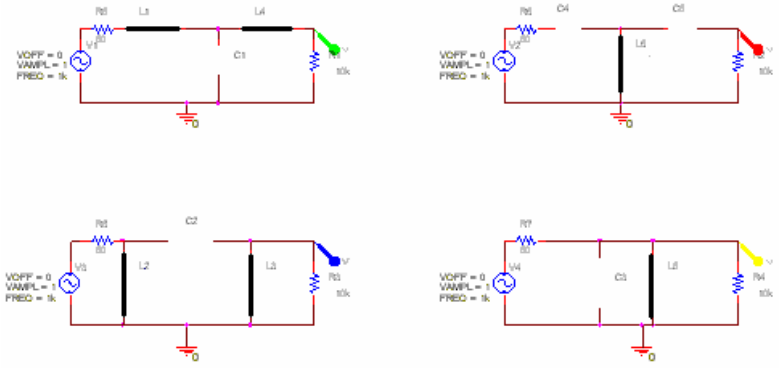


C

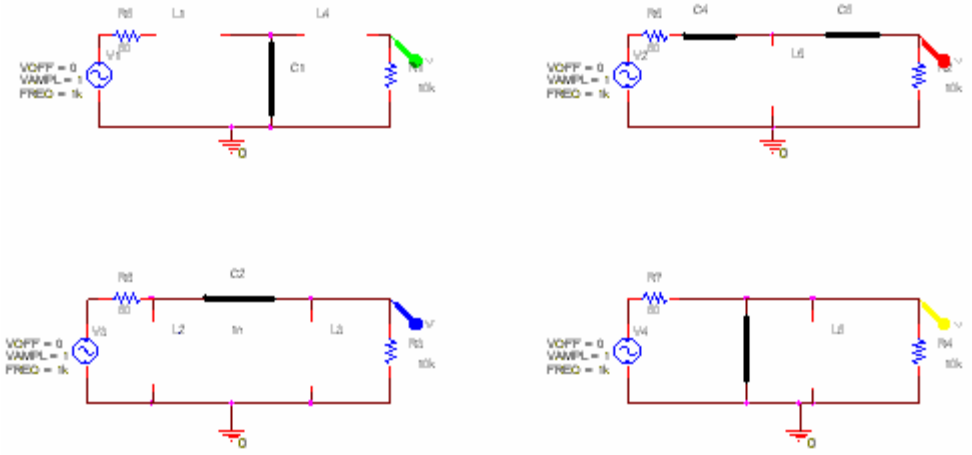


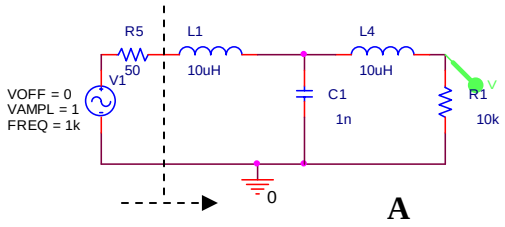
D

d. Simplify each circuit at DC (very low) frequencies by replacing the inductors and capacitors with short or open circuits, as appropriate. *(8 points)*

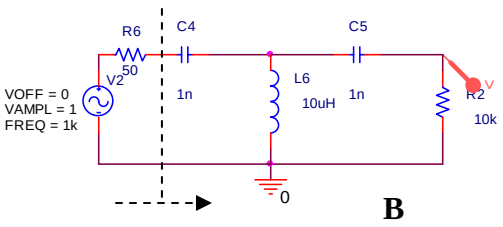


b. Simplify each circuit at very, very high frequencies by replacing the inductors and capacitors with short or open circuits, as appropriate. *(8 points)*

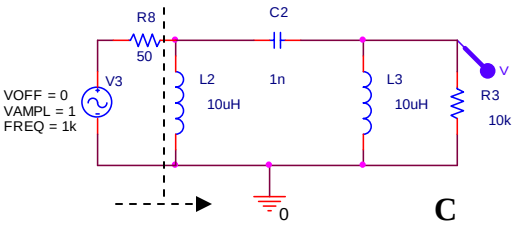




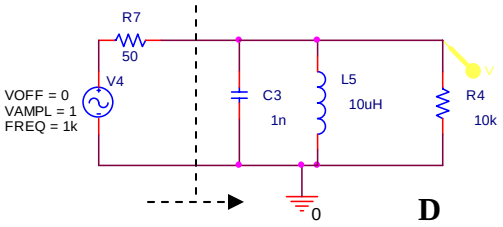
A



B

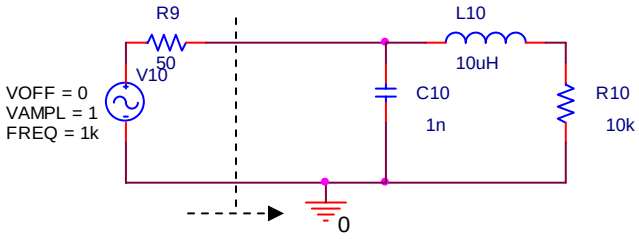


C



D

e. For each circuit, what resistance would be measured to the right of the dashed line at DC (very low) and very, very high frequencies? For example, for the following circuit, the resistance measured to the right of the dashed line would be 10k at DC and zero at very, very high frequencies. *(8 points :1 point each for low, 1 point each for high)*



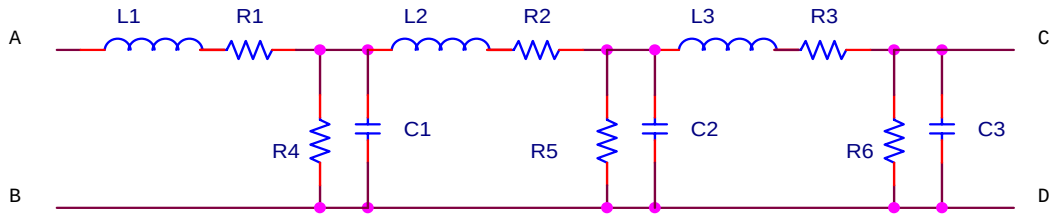
DC: A: R1=10K B: R is infinite C: R=0 D: R=0

High Frequency: A: R is infinite B: R=10K C: R=10K D: R=0

Fall 2003

4. Inductors and Capacitors at High and Low Frequency (20 points)

a) The circuit shown below is a delay line. That is, for some signals input at terminals A and B, the same signals will appear at terminals C and D, but delayed in time.



i) Simplify this circuit for zero frequency (DC) conditions *(4 points)*

ii) Simplify this circuit for very, very high frequencies *(4 points)*

iii) Given that no other components are connected to A&B or C&D, what is the resistance that would be measured at very low and infinite frequency at both sets of terminals? *(8 points)*

Assume R1=R2=R3=R4=R5=R6=2K ohms, C1=C2=C3=1μF, and L1=L2=L3=3mH

Very Low Frequencies	Very High Frequencies
R_{AB} =	R_{AB} =
R_{CD}=	R_{CD}=

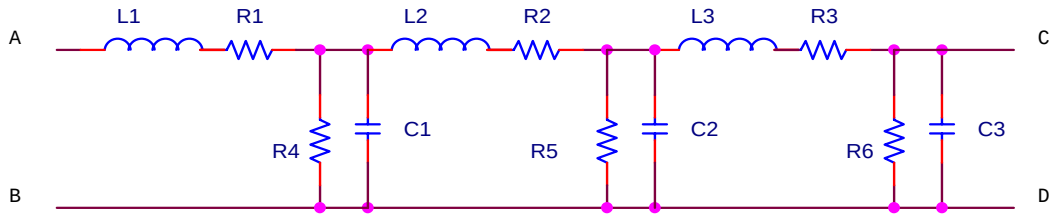
b) Many of you own devices that connect to your computers that have a thick cylindrical section that surrounds one of the power or signal cords. This is a magnetic material that adds inductance to both signal leads. The resulting circuit looks like the following.

Simplify this circuit at high and low frequencies. *(4 points)*

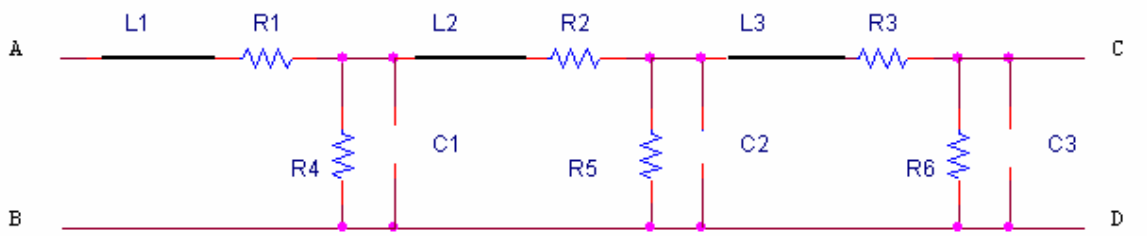
Fall 2003 solution

4. Inductors and Capacitors at High and Low Frequency (20 points)

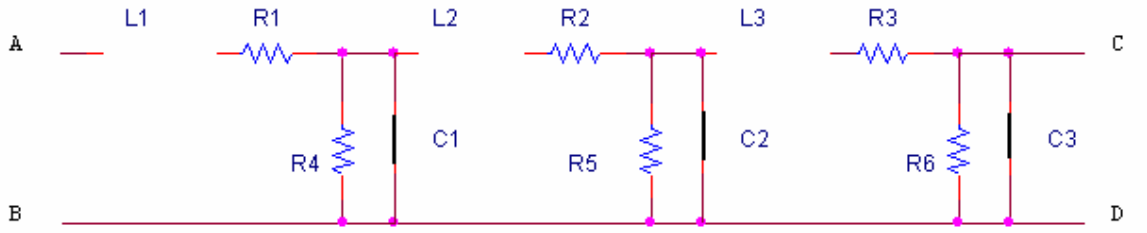
a) The circuit shown below is a delay line. That is, for some signals input at terminals A and B, the same signals will appear at terminals C and D, but delayed in time.



i) Simplify this circuit for zero frequency (DC) conditions *(4 points)*



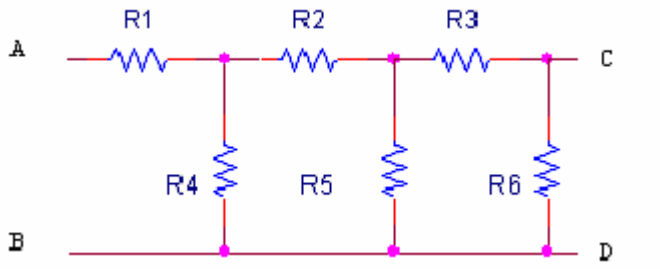
ii) Simplify this circuit for very, very high frequencies *(4 points)*



iii) Given that no other components are connected to A&B or C&D, what is the resistance that would be measured at very low and infinite frequency at the terminals indicated below? *(8 points)*

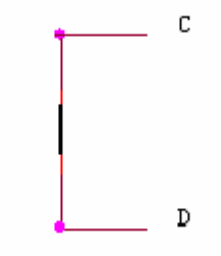
Assume R1=R2=R3=R4=R5=R6=2K ohms, C1=C2=C3=1μF, and L1=L2=L3=3mH

At low frequencies:



The total resistance between A and B is R1 + R4 // [R2 + R5 // (R6+R3)]
*R63 = 2K+2K=4K R563=2K*4K/(2K+4K)=1.33K R2563=2K+1.33K=3.33K*
*R42563 = 2K*3.33K/(2K+3.33K)=1.25K R142563=2K+1.25K = 3.25K ohms*

At high frequencies:



Since C and D are connected together by a wire, there is no resistance between them. (If it was an open circuit, the resistance would be infinite.)

Very Low Frequencies	Very High Frequencies
R_{AB} = 3.25K ohms	R_{CD}= 0 ohms

b) Many of you own devices that connect to your computers that have a thick cylindrical section that surrounds one of the power or signal cords. This is a magnetic material that adds inductance to both signal leads. The resulting circuit looks like the following.

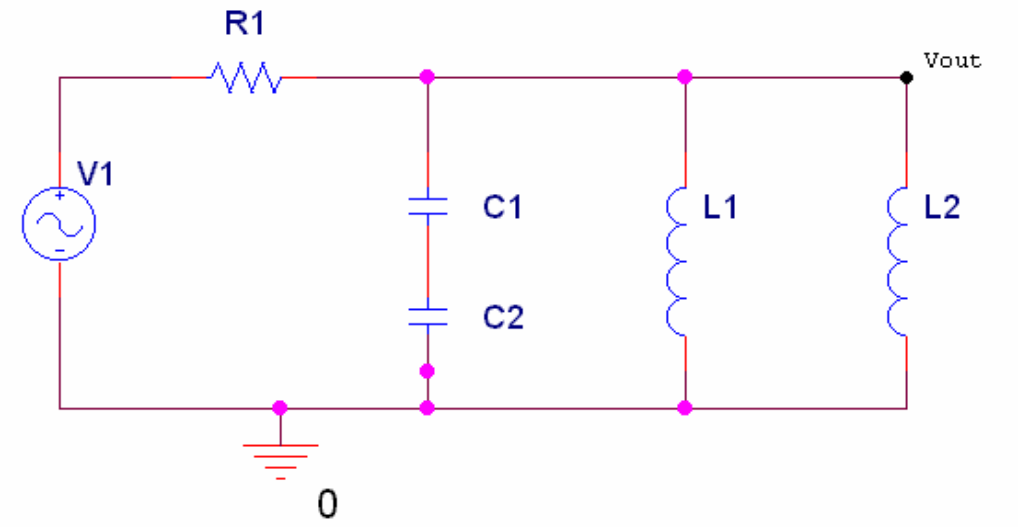
Simplify this circuit at high and low frequencies. *(4 points)*

High frequencies:

Low frequencies:

Spring 2003

4. Inductance and capacitance at very high and very low frequencies (20 points)



Consider the above circuit and apply your knowledge about the behavior of capacitors and inductors (i.e., open or short circuits at very high or very low frequencies).

a) (6 points) Redraw this circuit when V1 is very low frequency.

b) (2 points) According to your redrawn circuit, what would be the value of the voltage at Vout with respect to ground at very low frequencies? (Circle the best answer.)

Vout=0 Vout = V1 0<Vout<V1/R1 V1/R1<Vout<<V1

c) (6 points) Redraw this circuit when V1 is very high frequency.

d) (2 points) According to your redrawn circuit, what would be the value of the voltage at Vout with respect to ground at very high frequency? (Circle the best answer.)

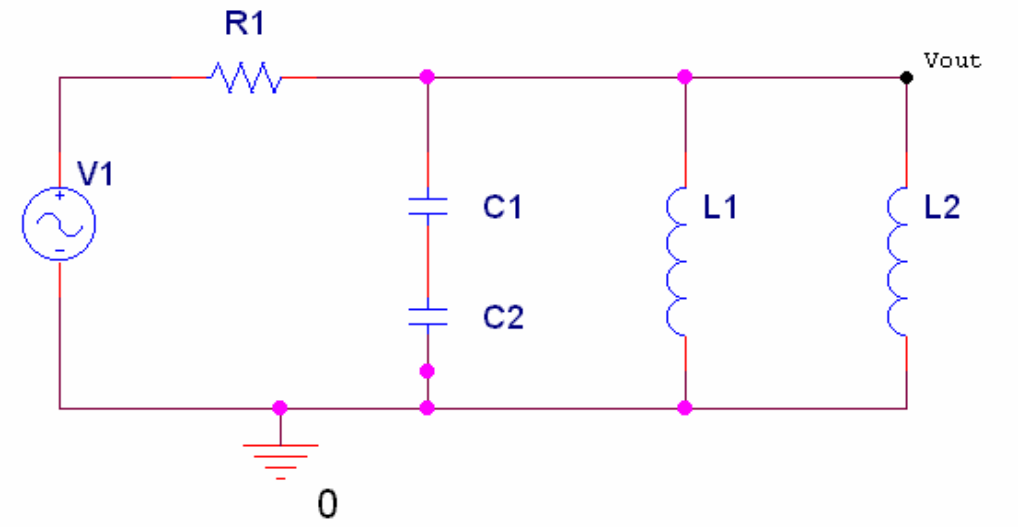
Vout=0 Vout = V1 0<Vout<V1/R1 V1/R1<Vout<V1

e) (4 points) Using your knowledge of filters, what kind of filter would you say this is? (Circle the best answer).

high pass filter low pass filter band pass filter band reject filter

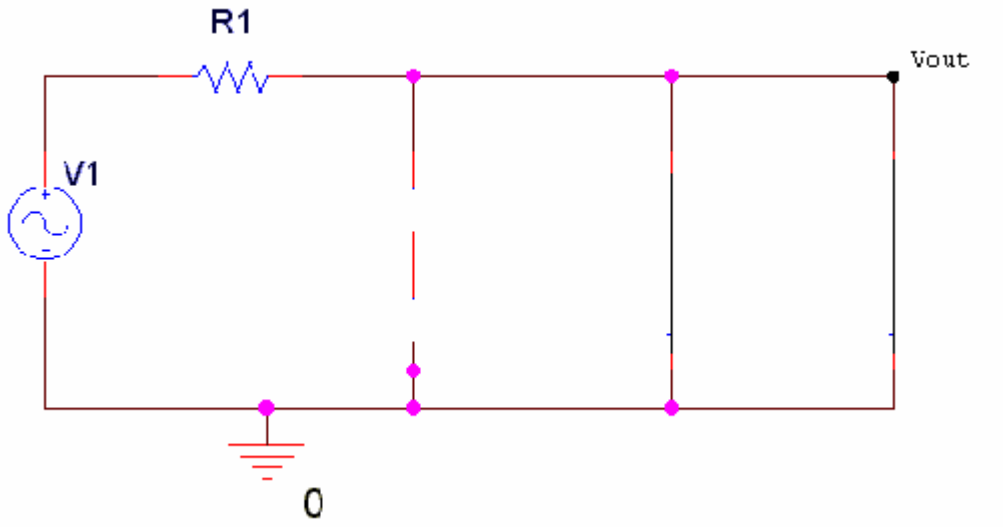
Spring 2003 solution

4. Inductance and capacitance at very high and very low frequencies (20 points)



Consider the above circuit and apply your knowledge about the behavior of capacitors and inductors (i.e., open or short circuits at very high or very low frequencies).

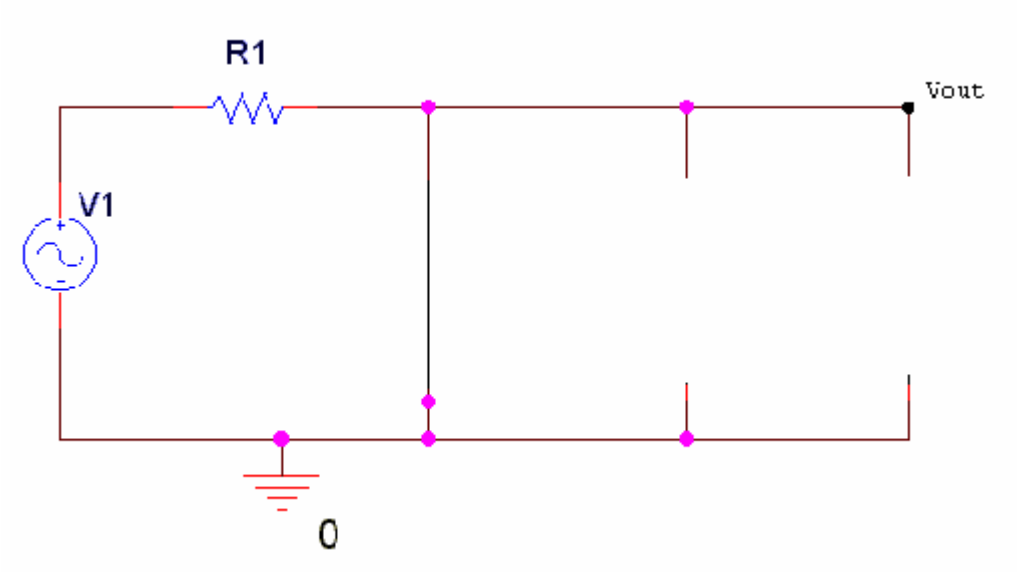
f) (6 points) Redraw this circuit when V1 is very low frequency.



g) (2 points) According to your redrawn circuit, what would be the value of the voltage at Vout with respect to ground at very low frequencies? (Circle the best answer.)

Vout=0 Vout = V1 0<Vout<V1/R1 V1/R1<Vout<<V1

h) (6 points) Redraw this circuit when V1 is very high frequency.



i) (2 points) According to your redrawn circuit, what would be the value of the voltage at Vout with respect to ground at very high frequency? (Circle the best answer.)

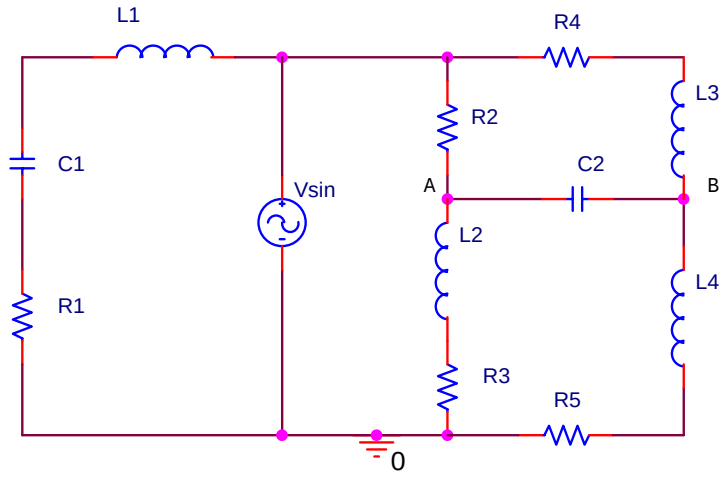
Vout=0 Vout = V1 0<Vout<V1/R1 V1/R1<Vout<V1

j) (4 points) Using your knowledge of filters, what kind of filter would you say this is? (Circle the best answer).

high pass filter low pass filter ***band pass filter*** band reject filter

Fall 2002

4. Inductance and capacitance at very high and very low frequencies (20 points). ***(WE HAVE NOT COVERED BRIDGES YET.)***



Consider the above circuit and apply your knowledge about the behavior of capacitors and inductors (i.e., open or short circuits at very high or very low frequencies).

k) Redraw this circuit when Vsin is low frequency (8 points).

l) At low frequencies, this circuit most behaves like a (circle one) (2 points)

open circuit short circuit bridge

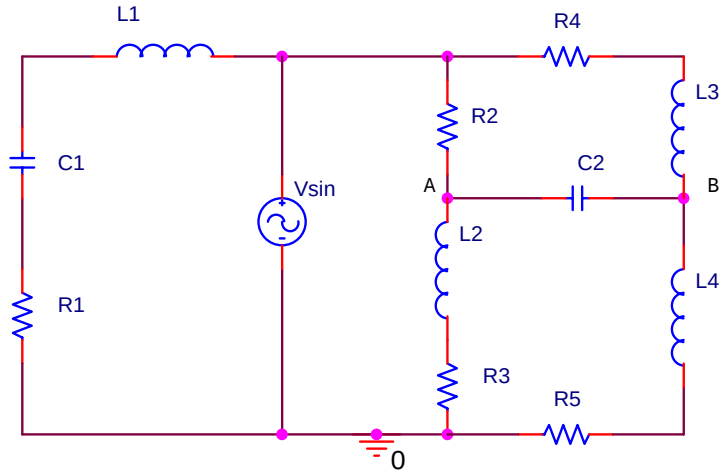
m) Redraw this circuit when Vsin is high frequency (8 points)

n) At high frequencies, this circuit most behaves like a (circle one) (2 points)

open circuit short circuit bridge

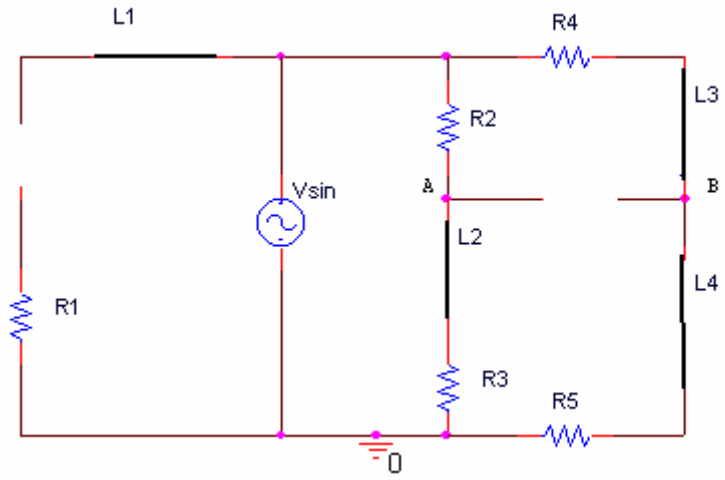
Fall 2002 solution (WE HAVE NOT COVERED BRIDGES YET.)

4. Inductance and capacitance at very high and very low frequencies (20 points).



Consider the above circuit and apply your knowledge about the behavior of capacitors and inductors (i.e., open or short circuits at very high or very low frequencies).

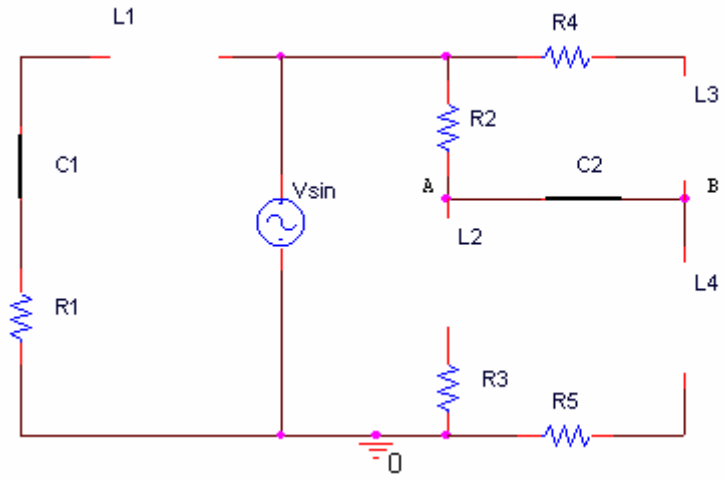
o) Redraw this circuit when Vsin is low frequency (8 points).



p) At low frequencies, this circuit most behaves like a (circle one) (2 points)

open circuit short circuit ***bridge***

q) Redraw this circuit when Vsin is high frequency (8 points)

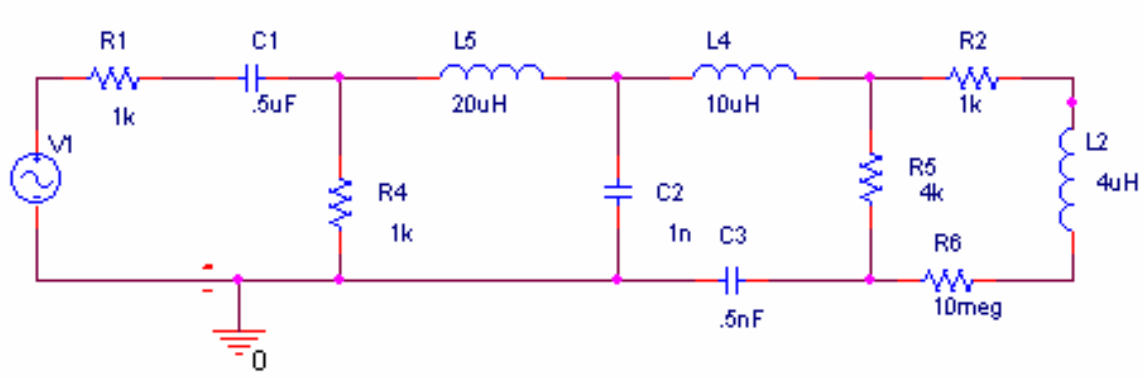


r) At high frequencies, this circuit most behaves like a (circle one) (2 points)

open circuit short circuit bridge

Spring 2002

4. Inductance and Capacitance at very high and very low frequencies (20 points).



Given that you know that inductors and capacitors can behave like short and open circuits at very high and low frequencies, we want to redraw the above circuit by replacing components that look like open circuits by open circuits and components that look like short circuits by short circuits.

a) Redraw this circuit at low frequencies (8 points).

b) At low frequencies, this circuit behaves most like (circle one) (2 points)

a voltage divider an open circuit a short

c) Redraw this circuit at high frequencies (8 points).

d) At high frequencies, this circuit behaves most like (circle one) (2 points).

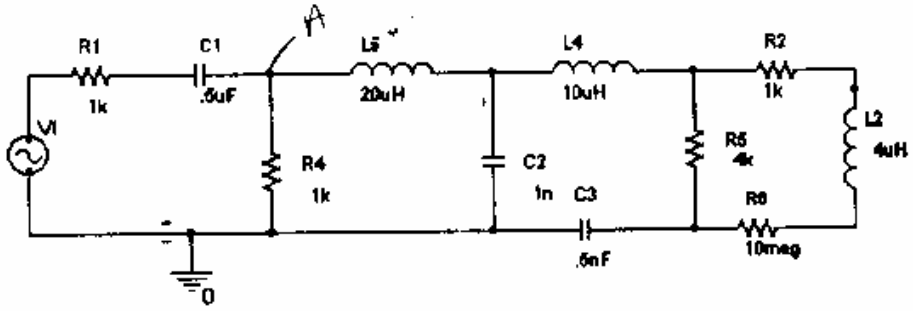
a voltage divider an open circuit a short

Spring 2002 solution

ENGR4300 Test 1A
Spring 2002

Name Answer key
Section _____

4. Inductance and Capacitance at very high and very low frequencies (20 points).



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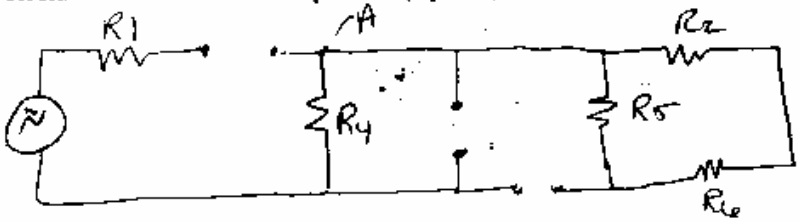
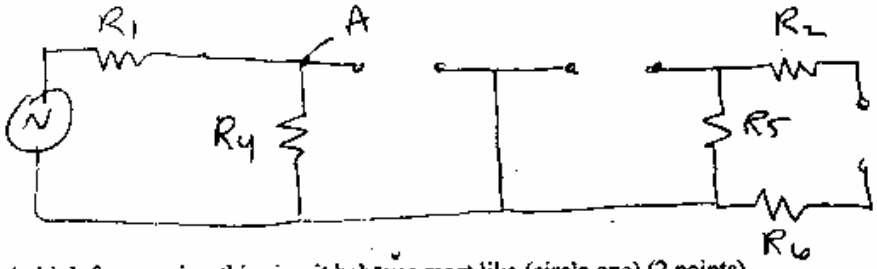
a) Redraw this circuit at low frequencies (8 points).



b) At low frequencies, this circuit behaves most like (circle one) (2 points)

a voltage divider (an open circuit) a short an op amp

c) Redraw this circuit at high frequencies (8 points).



d) At high frequencies, this circuit behaves most like (circle one) (2 points).

(a voltage divider) an open circuit a short an op amp

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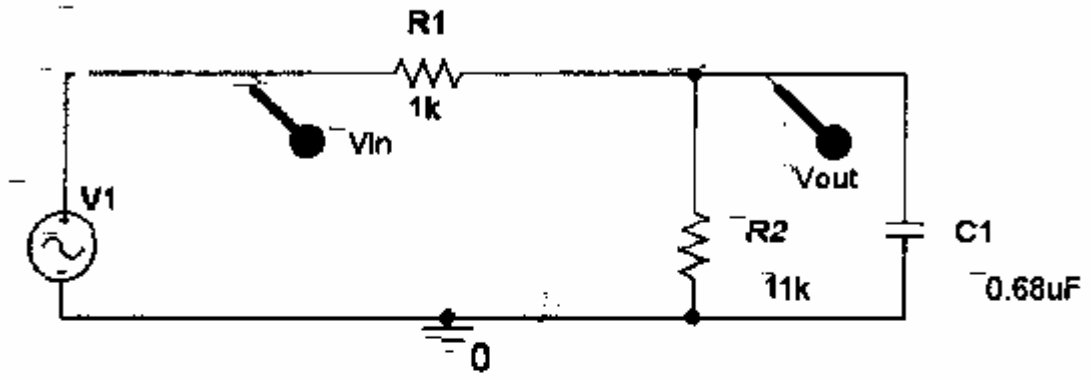
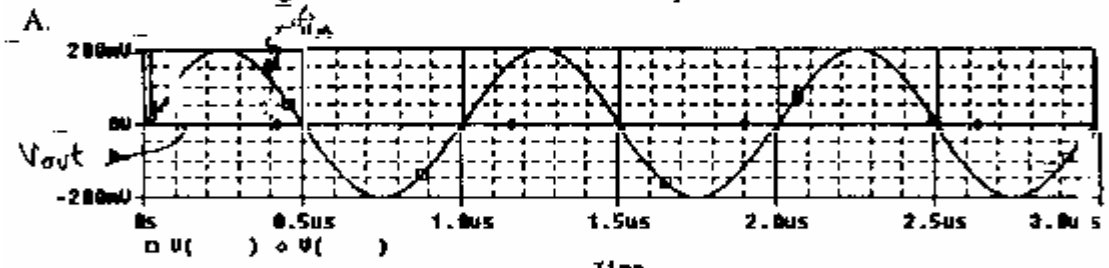
4. Simulation Results (20 points)

You have created the following circuit in Pspice:

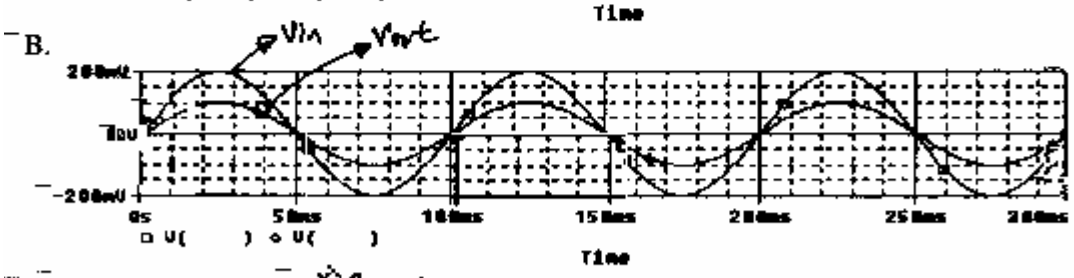


You run the following three transients at different frequencies:

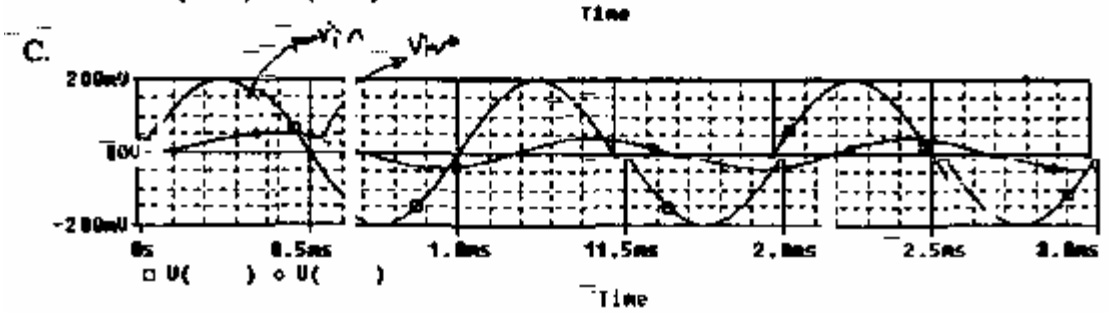
A.



B.



C.



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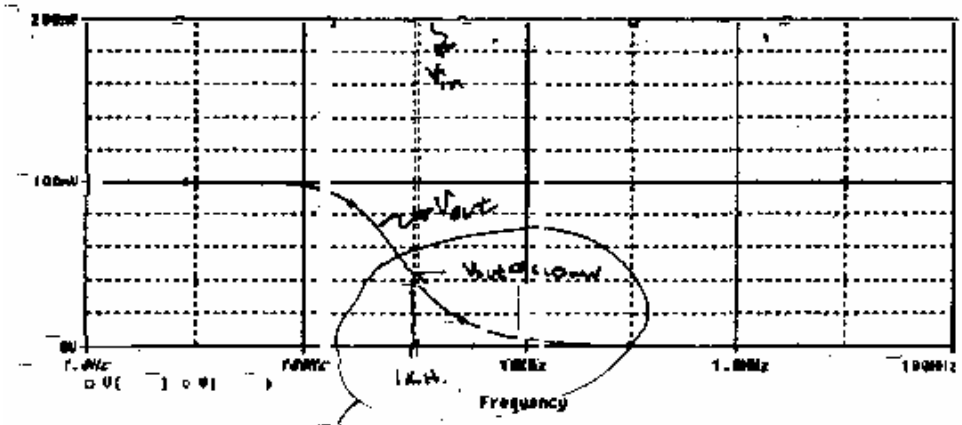
Next, you run an AC sweep and get the following results:



1. Identify the input voltage (V_{in}) and the output voltage (V_{out}) signals on the AC sweep plot and the three transient response plots: (7 points)

2. Which of the three transient plots (A, B or C) most likely represents the response at 1 kHz (5 points)

C

3. The above circuit best represents (pick one): (3 points)

a. high pass filter

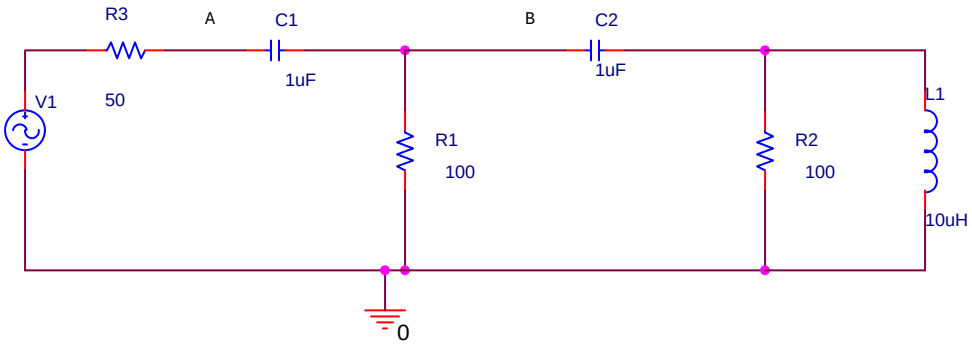
(b. low pass filter)

Why? (5 points)

Since it passes low frequencies ($V_{out} \neq 0$ if f is small) but stops high frequencies ($V_{out} \approx 0$ if f large).

Fall 2000

2. Inductors and Capacitors at Very High and Very Low Frequencies (20 Points)



Given that you know inductors and capacitors can be short or open circuits at very low frequencies (at or very near to DC) and at very high frequencies, we want to redraw the circuit above by replacing components that look like open circuits by open circuits and replacing components that look like short circuits by short circuits.

a. First simplify the circuit for low frequencies. Label the points A and B on your simplified circuit.

b. Second, simplify the circuit for high frequencies. Label the points A and B on your simplified circuit.

Fall 2000 solution

(not yet available)