ENGR4300 Test 1A and B
Spring 2004

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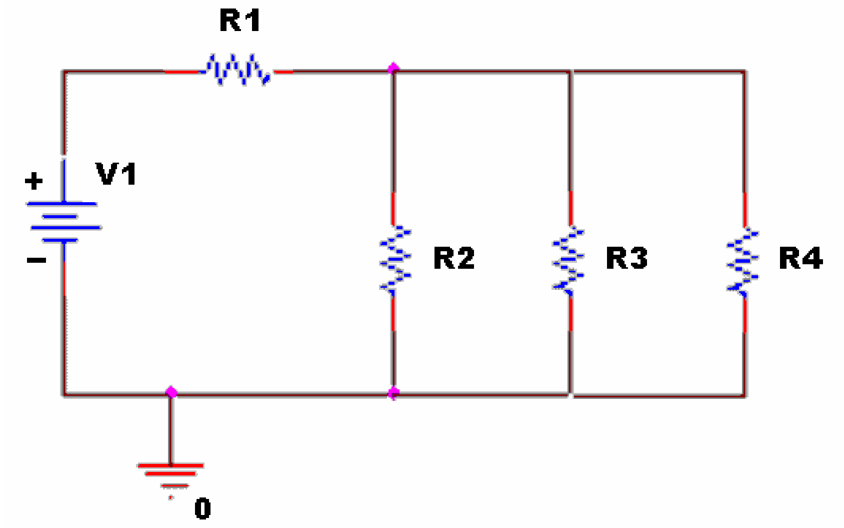
1) Resistive Circuits (16 points)



A: In the circuit above, V1=5 volts. R1= 50? , R2= 1000? , R3= 2000? , R4= 3000?

a) Find the voltage across R1. *(8 points)*

1/(R234) = 1/R2 + 1/R3 + 1/R4 = 1/1K + 1/2K + 1/3K R234=545.5 ohms

VR1 = (R1/(R1+R234))V1 = (50/(50+545.4))5 = 0.42V ***VR1=0.42V***

b) Find the current through R4. *(8 points)*

VR4 = V1-VR1 = 5-0.42=4.58V

IR4 = VR4/R4 = 4.58/3000 = 1.53EE-3 amps ***IR4 = 1.53 mA***

B: In the circuit above, V1=5 volts. R1= 50? , R2= 500? , R3= 1000? , R4= 500?

c) Find the voltage across R1. *(8 points)*

1/(R234) = 1/R2 + 1/R3 + 1/R4 = 1/500 + 1/1000 + 1/500 R234=200 ohms

VR1 = (R1/(R1+R234))V1 = (50/(50+200))5 = 1V ***VR1=1 V***

d) Find the current through R4. *(8 points)*

VR4 = V1-VR1 = 5-1=4V

IR4 = VR4/R4 = 4/500 = 8EE-3 amps **IR4 = 8 mA**

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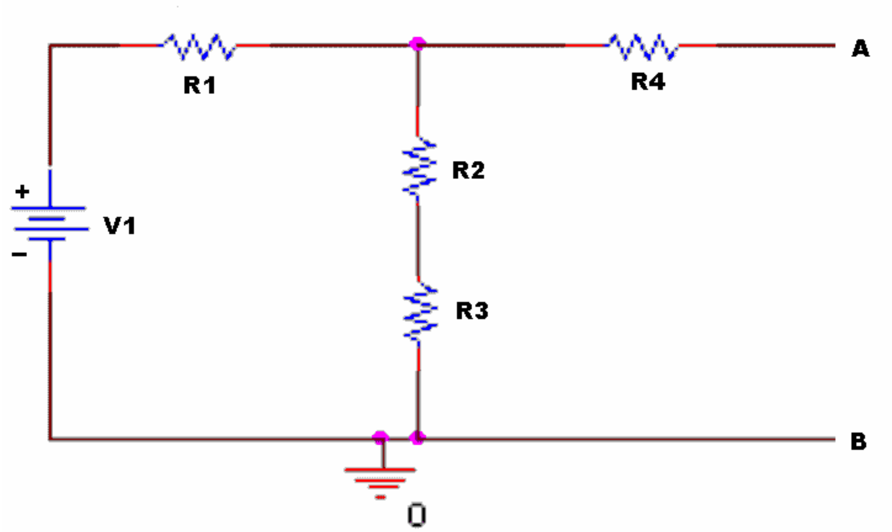
2) Thevenin circuits (20 points)



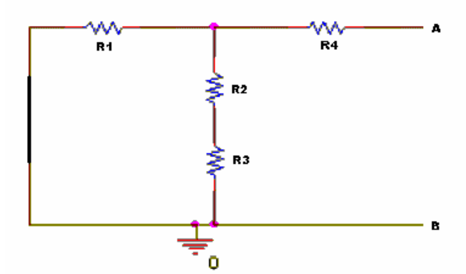
A: In the circuit above, V1=6 volts. R1= 50? , R2= 500? , R3= 800? , R4= 3000?

a) Find the Thevenin Voltage (Voc) of the Circuit *(8 points)*

VA = [(R2+R3)/(R1+R2+R3)]V1 = (1300/1350)6 = 5.78 V VB = 0

Vth = VA-VB = 5.78V

b) Find the Thevenin Resistance *(8 points)*




```
A ---R4--+------R1-----+-------B
         |             |
         +----R2----R3--+
```

*Rth = R4 + [(R1*R23)/(R1+R23)] R23=500+800=1300*
*Rth=3000+[(50*1300)/(50+1300)]=3048.15 ohms* ***Rth=3048 ohms***

c) If you place a load resistor of 2K between A and B, what would be the voltage at point A? *(4 points)*

VA = [RL/(RL+Rth)]Vth = [2K/(2K+3048)]5.78 = 2.29V **VA = 2.29V**

B: In the circuit above, V1=6 volts. R1= 50? , R2= 1000? , R3= 500? , R4= 2000?

a) Find the Thevenin Voltage (Voc) of the Circuit *(8 points)*

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VA = [(R2+R3)/(R1+R2+R3)]V1 = (1500/1550)6 = 5.806 V VB = 0

Vth = VA-VB = 5.806V

b) Find the Thevenin Resistance *(8 points) [see pictures for A]*

*Rth = R4 + [(R1*R23)/(R1+R23)] R23=1000+500=1500*
*Rth=2000+[(50*1500)/(50+1500)]=2048.38 ohms* ***Rth=2048 ohms***

c) If you place a load resistor of 2K between A and B, what would be the voltage at point A? *(4 points)*

VA = [RL/(RL+Rth)]Vth = [3K/(3K+2048)]5.81 = 3.45V **VA = 3.45V**

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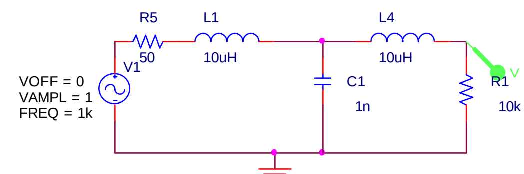
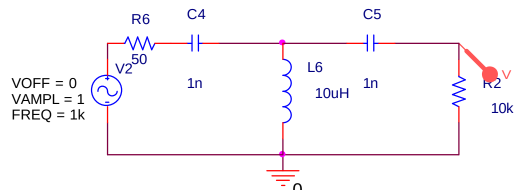
3) Circuits at Low and High Frequencies (24 points) [Both A and B]

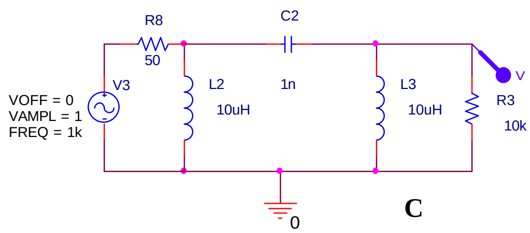
The following four circuits are analyzed using PSpice:



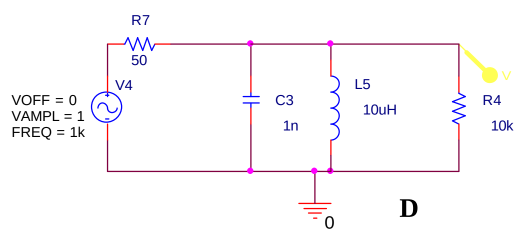
A



B

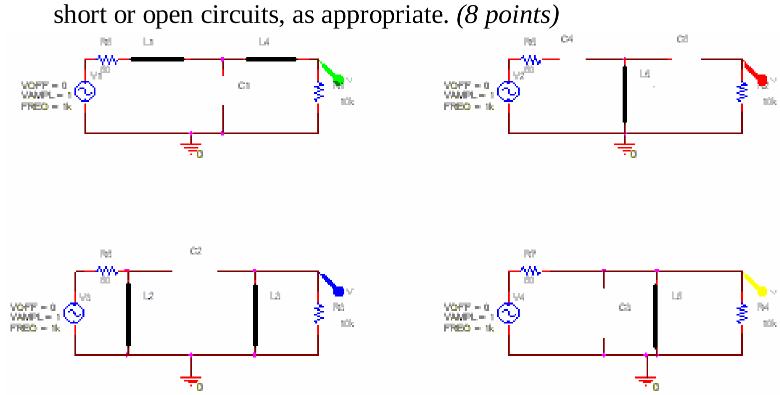


C

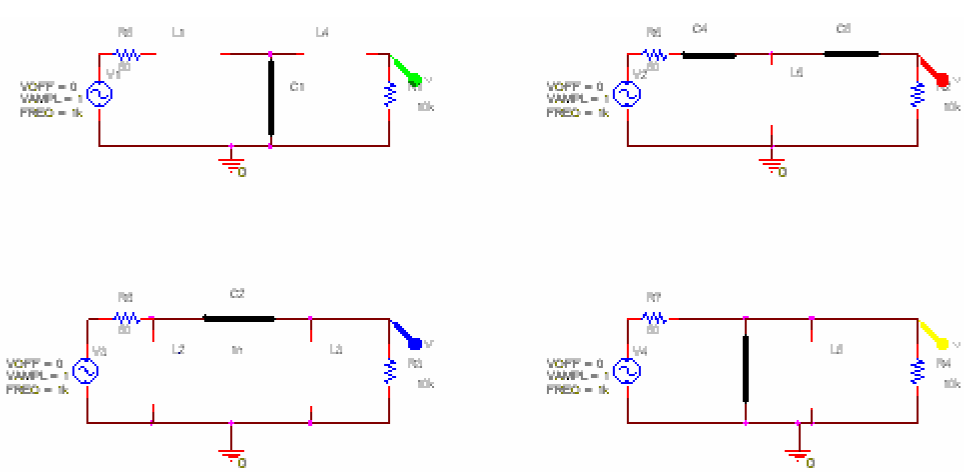


D

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)*



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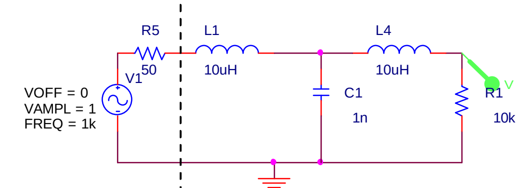
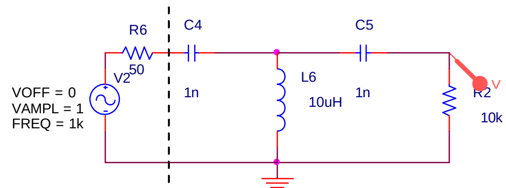
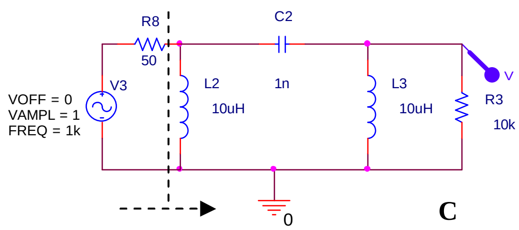


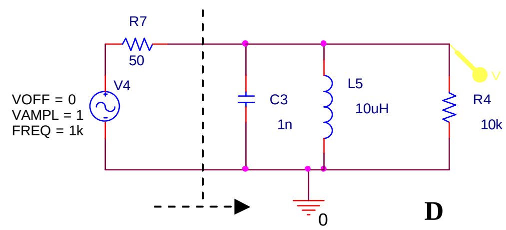
A



B

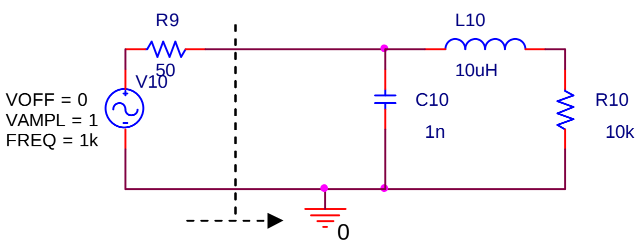


C



D

b. 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

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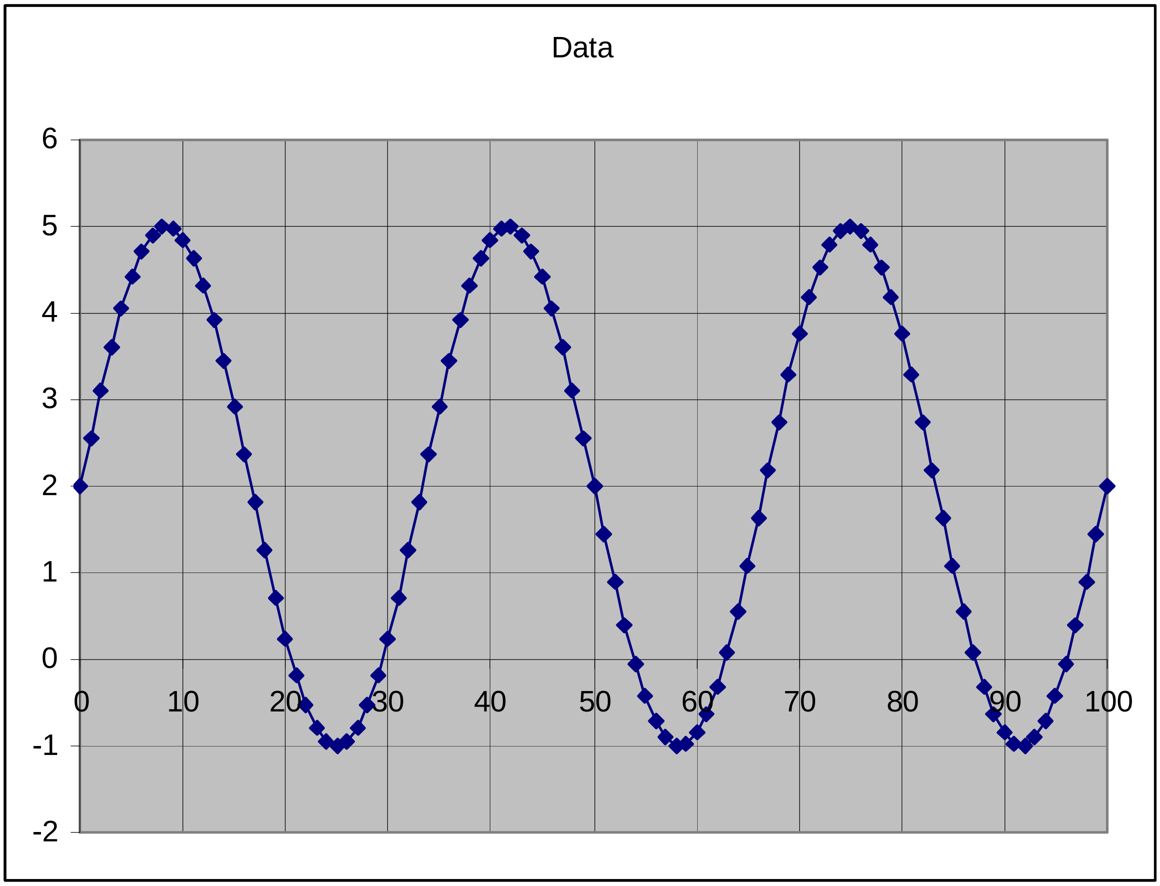
4) Sinusoids (20 points) [Both A and B]

The following data was created using Excel.



a. Assuming the horizontal scale is in seconds, find the frequency and period of this signal. Include units. *(4 points)*

T=33s – 0 ***T=33s***
f = 1/33s ***f = 0.03 Hz***

b. What is the DC offset of this signal? Include units. *(2 points)*

VDC = 2V

c. What is the phase of the signal? Include units. *(2 points)*

phase = 0 degrees or 0 radians

d. Write the mathematical expression for this signal and its offset. In general, this is given by $X = X_o + X_1 \sin(\omega t + \theta_o)$ which accounts for its frequency and phase shift. *(2 points)*

*ω =2π f = 2*3.24*0.03 = 0.1885 rad/sec* ***X = 2V + 3V sin (0.1885 t)***

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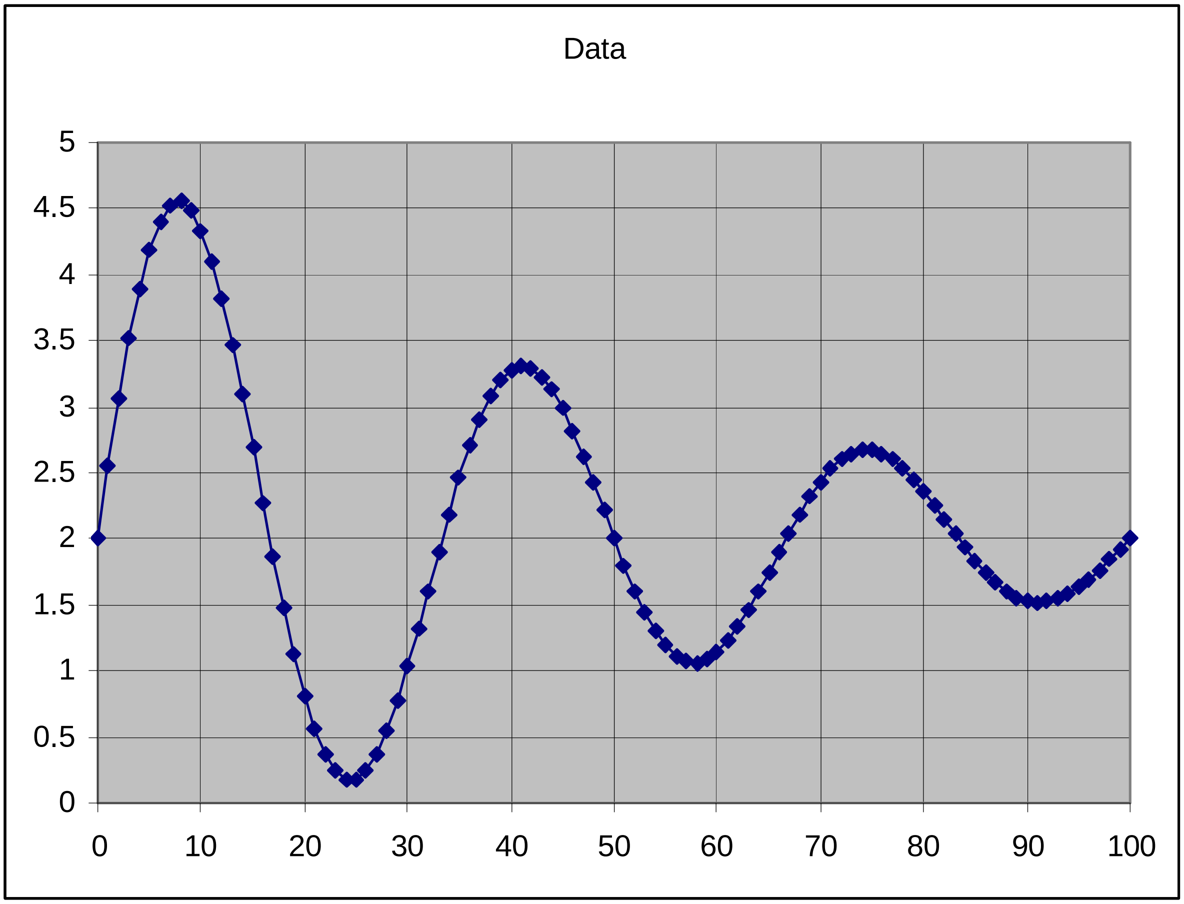
The same data with damping looks like:



e. Find the damping constant ? for this data. Include units. *(6 points)*

VDC = 2V Therefore, let V=2V be the zero point. V0=(7s, 4.6-2) = (7,2.6)
V1=(74s,2.7-2) =(74,0.7)
V1 = V0 $e^{-? (t1-t0)}$ *0.7 = 2.6* $e^{-? (74-7)}$ *-? (67)=ln(0.7/2.6)* ? ***=0.0196/s***

f. Write the mathematical expression for this data $X ? X_o ? X_1 \sin ? t ? ?_o ? e^{?? t}$ Your units must be consistent. *(4 points)*

From part d we know that:
VDC = 2V Amplitude = 3V f=0.03Hz w=2? f=0.1885 rad/sec

X = 2V + 3V sin (0.1885 t) $e^{-0.0196\, t}$

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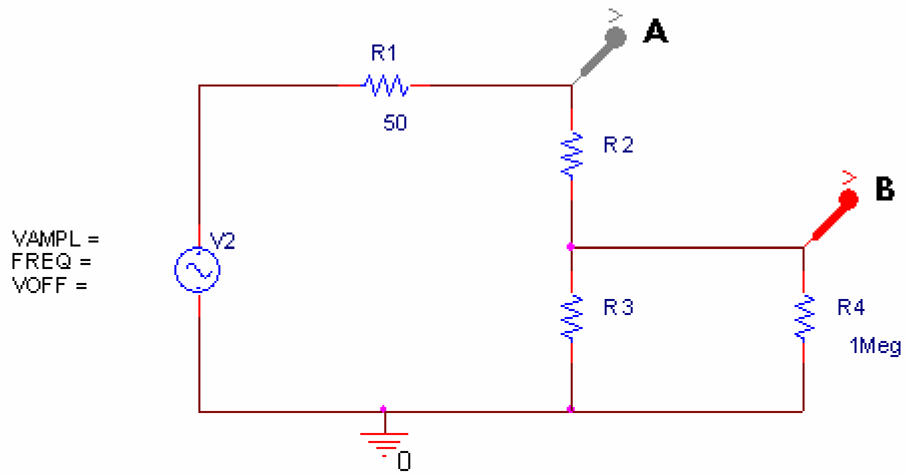
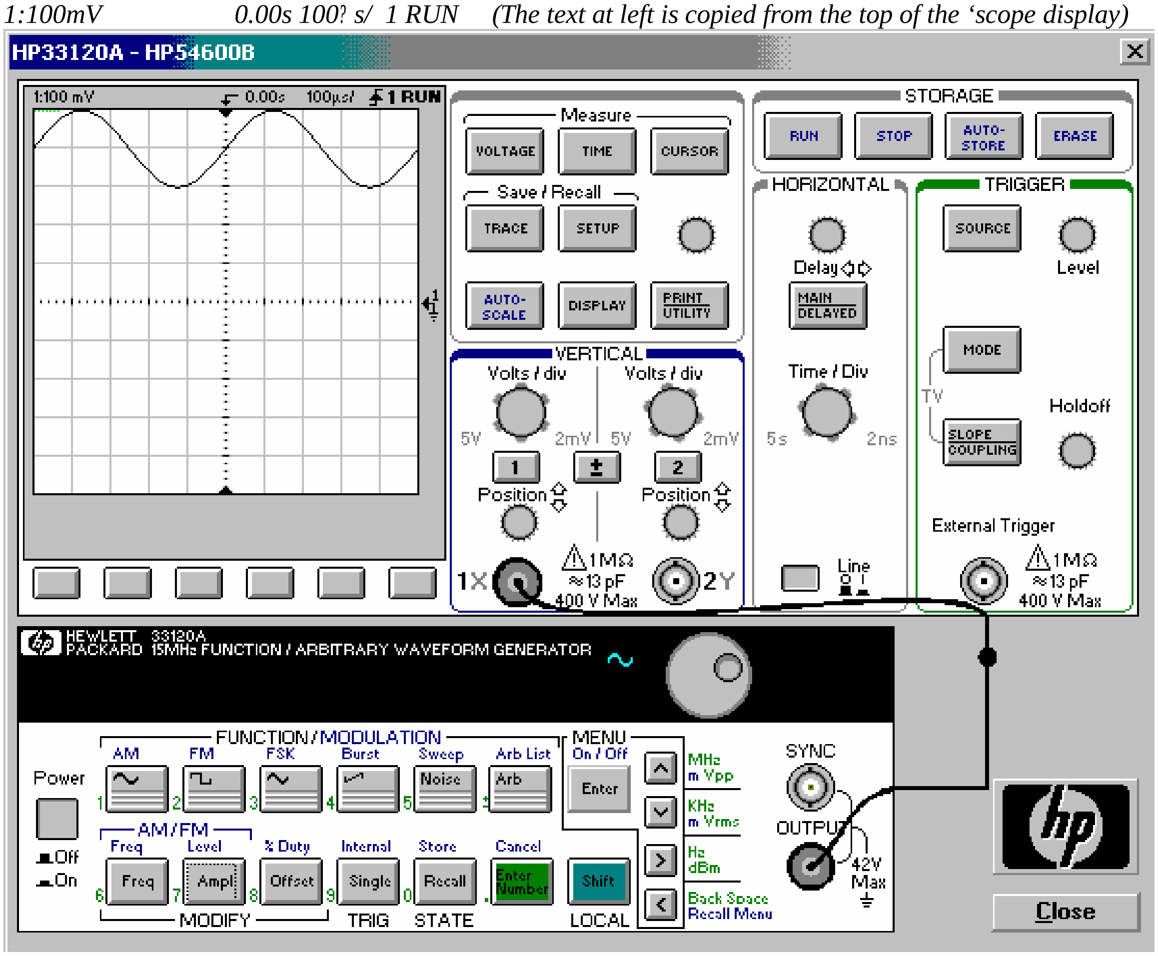
5) Instrumentation and PSpice (20 points)



A: The circuit above shows a model of voltage divider circuit created in PSpice where **R2=2K** ohms and **R3=2K** ohms. Below is a picture of the 'scope and function generator. It shows the input signal measured at marker A.

B: The circuit above shows a model of voltage divider circuit created in PSpice where **R2=1K** ohms and **R3=3K** ohms. Below is a picture of the 'scope and function generator. It shows the input signal measured at marker A.

1:100mV 0.00s 100? s/ 1 RUN (The text at left is copied from the top of the 'scope display)



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1) About what must be the parameters of the VSIN source to create the signal at A? *(3 points)****[A and B]***

VAMPL = ***100mV*** FREQ = 1/(5*100*10EE-6)=***2K*** VOFF = ***400mV***

2) We want to create the actual circuit using the function generator, two resistors and both channels of the ‘scope. Be as specific as possible in your answers)

a) How would you physically wire the circuit and connect it to the equipment? *(5 points)*

[A and B] *Note that R1 is the internal resistance of the function generator and R4 is the internal resistance of the ‘scope. They are not resistors in the circuit.*

A. Wire the circuit
1. Use an alligator clip to connect one end of R2 to one end of R3.
2. Connect a “T” to the output of the function generator.
3. Connect a BNC cable to one end of the “T”
4. Connect a mini-grabber connector to the other end of the BNC cable.
5. Connect the red lead of the mini-grabber to the free end of R2
6. Connect the black lead of the mini-grabber to the free end of R3
B. Connect the ‘scope
1. Connect the other end of the “T” in the output of the function generator to a BNC cable.
2. Connect the other end of this cable to channel 1 of the ‘scope.
3. Connect another BNC cable to channel 2 of the ‘scope.
4. Connect a mini-grabber connector to the end of this BNC cable.
5. Connect the red lead from the mini-grabber to the end of R3 which is in direct contact with R2.
6. Connect the black lead from the mini-grabber to the end of R3 which is connected via a black lead directly to the function generator.

Answers may vary

b) How would you manually set up the function generator to display the signal represented by V2? *(5 points)*
[A and B]

1. Set the Frequency by pressing the “Freq” button and turning the dial until the display on the function generator reads 2K.
2. Set the amplitude by pressing the “Ampl” button and turning the dial until the display on the function generator reads 100mV p-p [which is equivalent to 100mV amplitude – ½ desired]
3. Set the DC offset by pressing the “Offset” button and turning the dial until the display on the function generator reads 200mV [which is equivalent to 400mV – ½ desired]

c) How would you manually adjust the ‘scope to display the input signal shown? *(5 points)*
[A and B]

1. Set the vertical scale by pressing the “1” key for channel 1 and turning the “Volts/div” dial until the display in the upper left corner of the screen reads 1:100mV.
2. Set the horizontal scale turning the “Time/Div” dial until the display in the center right of the screen reads 100? s/.
3. Turn the position knob for channel 1 until the <--1 arrow aligns with zero.

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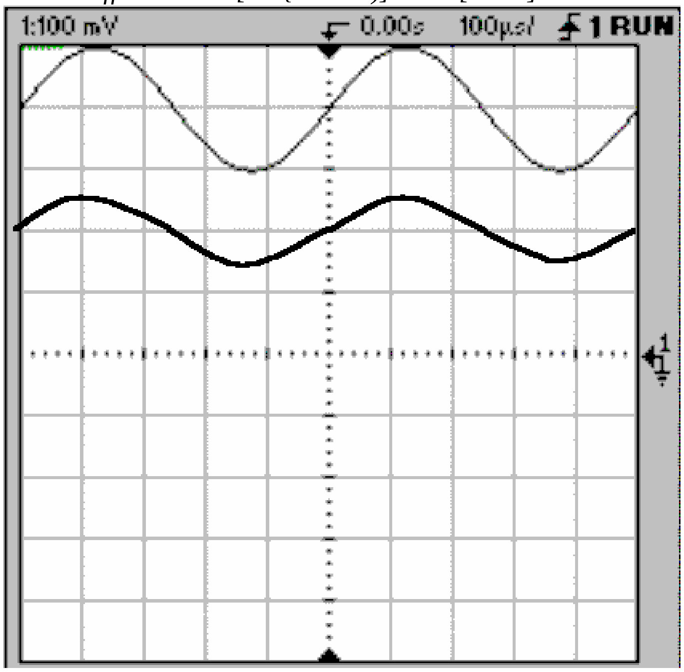
d) Sketch the output signal at marker B on the screen on the previous page. *(2 points)*

[A only]

Amplitude: Vout=[R3/{R3+R2)]Vin = [1k/2k]100mV = 50mV

DC offset: Vdc = [R3/{R3+R2)]Vin = [1k/2k]400mV = 200mV



[B only]

Amplitude: Vout=[R3/{R3+R2)]Vin = [3k/4k]100mV = 75mV

DC offset: Vdc = [R3/{R3+R2)]Vin = [3k/4k]400mV = 300mV