Phy 415/515 Lab #2 2009 Ac signals and RC circuits

Experiment

This lab begins with more familiarization with equipment used in circuit analysis, including a function generator, oscilloscope and computerized data collection. You will turn in the results sheet as well as a print out of the computerized data collection.

1. Set up the breadboard

1.1. Power strips

As you did for the first lab, connect the black socket on the breadboard to the 4th row on top of breadboard and jumper down to the rightmost column of one of the wiring blocks (which we will call “-V” or “ground” column). Connect the leftmost red socket to the top row on the breadboard and jumper down to the leftmost column, which we will call the “+V” column. DO NOT CONNECT THE KEPCO power supply—we will use the function generator instead. Set up a “probe” socket and column on the breadboard, and connect it to the oscilloscope. Use a long yellow wire to jumper the probe column to the ground column. Repeat the steps from the first lab to get a trace observable on the scope. Move the probe wire to the “+V” column.

2. Function Generator

2.1. DC signals

The on switch for the Wavetek Function Generator is on the frequency scale. Set the waveform to dc. Set the dc offset to zero. Using a bnc to banana connector (connect to far right output, “Hi”), connect the output to the breadboard as the power source. Change the dc offset and observe the voltage on the scope. **Record the range of output voltages.**

2.2. Sinewave

Turn the dc offset “off” (make sure knob is pressed in) and change the waveform to a sinewave. Set the frequency to 1 kHz. Turn the frequency multiplier knob to "1". Adjust the amplitude on the function generator to maximum. In the timebase controls of the oscilloscope, set the timescale to 1 ms/div. Set the trigger to internal for T932 and Edge for TDS 1001B (this allows the oscilloscope to start the display at the same voltage each time, so it is possible to get it to stop moving). Adjust the trigger level until it actually stops moving. Adjust the timebase position until you can see the start of the trace. Observe the effect of changing the trigger level--it changes where the sine wave starts. Observe that changing the amplitude of the sine wave or the volts per division changes the effect of the trigger level, since the trigger level is defined in terms of divisions. Adjust the amplitude back to maximum and readjust the trigger level if necessary. **Record the maximum amplitude of the sinewave.**

2.3. Period

Change the timebase position to have a zero crossing at the center of the oscilloscope display. **Measure and record the period of the oscillation and compute the frequency, f=1/T**.

2.4. Waveforms

Set the frequency adjust knob to 0.5 and observe the display. Change the waveform to triangle. **Measure and record the period of the oscillation and compute the frequency**. Change the waveform to square wave and **measure the period**.

Change back to a sine wave.

2.5. Clipping

Set the dc offset to zero and then increase it. Observe that the waveform “clips” (goes flat) when the sum of the sine wave plus offset would exceed some maximum voltage. **What is the maximum output voltage of the function generator?** Adjust the dc offset negative. **What is the minimum output voltage of the function generator?**

2.6. AC coupling
Adjust the amplitude and offset to both be 5 V (so the wave runs from 0-10V), then change the scope coupling to ac. **What is the dc offset when observed with ac coupling?** Turn the dc offset off. Set the scope to 2 V/div.

2.7. Amplitude vs. frequency
Change the frequency scale on the generator to 100 Hz and change the time scale on the oscilloscope to about 5 ms/div. **What is the amplitude of the sine wave**?
Change the frequency scale on the generator to 10 KHz and change the time scale on the oscilloscope to 0.05 ms/div. **What is the amplitude of the sine wave**? Note that the amplitude is fairly constant.

3. High Pass Filter

3.1. Wire
Wire a high pass circuit on the breadboard, as shown in Figure 1. Move the probe wire to the output.

3.2. High Frequency Response
What is the amplitude of the response with the frequency set to 10 kHz?

3.3. Low Frequency Response
Set the frequency to 100 Hz. **What is the amplitude of the response?**

3.4. Cut off frequency
At what frequency is the amplitude approximately 70% of maximum? This is f_c.

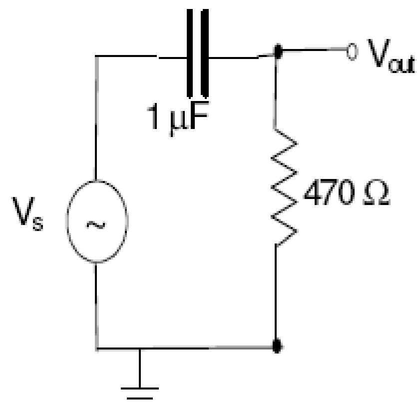

Figure 1. High pass circuit.

3.5. Roll off
At what frequencies is the amplitude approximately 50% and 30% of maximum?
Disconnect the circuit

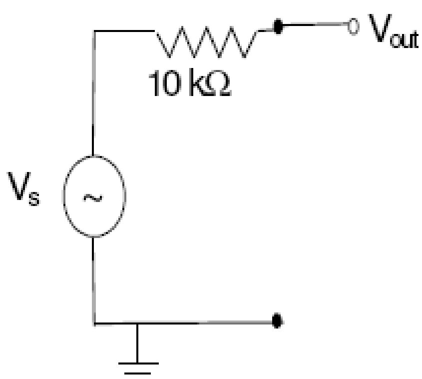

Figure 2. Scope measurement circuit

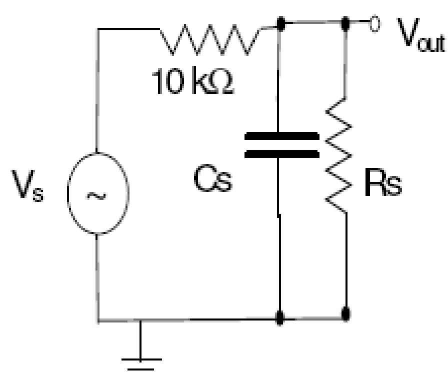

Figure 3. Scope measurement circuit including scope.

4. Scope Impedance
Wire the 10kΩ resistor as shown in Figure 2. The circuit including the scope resistance and capacitance is shown in Figure 3. **What is the output voltage amplitude at 1 kHz? What is the output voltage amplitude at 1 MHz? At what frequency does the amplitude drop to 70% of the low frequency amplitude?** At that frequency, the impedance of the scope capacitor:

$$|Z| = \frac{1}{2\pi fC}$$

is about the same as the 10kΩ resistor. **What is the scope capacitance?**

5. Computer Digital Oscilloscope

5.1. DC voltage input

Set the function generator to dc. Set the dc offset to 5 volts, read with either the scope or the DVM. Turn on the computer and click on the Voltage icon. Set the collection rate to 5000 samples/s. The collection time should be about 0.2 s.

5.2. Voltage Divider

Wire a 10k voltage divider. Move the red alligator clip of the computer differential voltage probe to the "probe" red banana socket, connected to the "probe" row. Connect the voltage probe wire to the ground column and zero the probe (select "0 Zero" on screen). Move the probe wire from ground to the +V **and measure the input voltage with the computer.** **(If input is not around 5 V contact lab TA)** Then to the output of the 10K voltage divider, while reading the voltage on the screen. **What is the output of the voltage divider? What is the impedance of the voltage sensors?** (hint: what should output for this divider be considering input?)

5.3. AC input

Move the probe wire to the "+V" column. Set the function generator to sine (the amplitude should still be 5V) and set the frequency to 100 Hz. Turn the dc offset off.
Click on collect and measure the amplitude of the sinewave: select part of the data, click on "curve fit" and select sine. **Record the amplitude**. (be sure your significant digits make sense)

6. Low pass

Wire the low pass circuit as shown in Figure 4.
Connect the probe to the output. Record the output on the computer at 100 Hz. **Print the plot with fitted curve**.
Change the frequency to 500 Hz and **repeat**.
What is the cutoff frequency of the circuit?

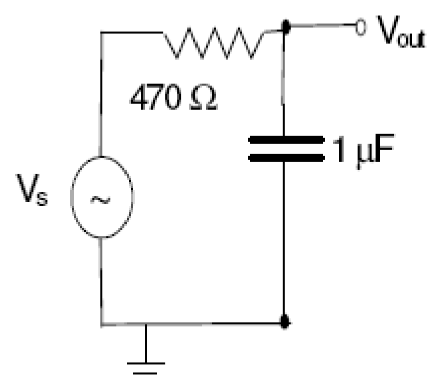

Figure 4. Low Pass Filter

Name: ____
Lab Partner Name: ____

2. Function Generator
2.1. DC signals
Record the range of output voltages ____________________________
2.2. Sinewave
Record the maximum amplitude of the sinewave______________
2.3. Period
Measure and record the period of the oscillation ______________and compute the frequency, f=1/T______________.
2.4. Waveforms
Measure and record the period of the oscillation ______________and compute the frequency______________.
Square wave period______________
2.5. Clipping
Maximum output voltage of the function generator______________
Minimum output voltage of the function generator______________
2.6. AC coupling
Dc offset when observed with ac coupling______________
2.7. Amplitude vs. frequency
Amplitude of the sine wave at 100 Hz ______________
Amplitude of the sine wave at 10 kHz ______________

3. High Pass Filter
3.2. High Frequency Response
Amplitude of the response at 10 kHz _________
3.3. Low Frequency Response
Amplitude of the response at100 Hz _________
3.4. Cut off frequency
At what frequency is the amplitude approximately 70% of maximum? ____________
3.5. Roll off
At what frequencies is the amplitude approximately 50% and 30% of maximum?
50% _______________ 30% _______________

4. Scope Impedance
What is the output voltage at 1 kHz? _________
What is the output voltage at 1 MHz? _________
At what frequency does the amplitude drop to 70% of the low frequency amplitude? _________.
What is the scope capacitance? _________

5. Computer Digital Oscilloscope
5.2. Voltage Divider
What is the input voltage? ______________
What is the output of the voltage divider? ___________
What is the impedance of the voltage sensors? __________
5.3. AC input
Amplitude at 100 Hz_________

6. Low Pass Filter
What is the cutoff frequency of the circuit? _________