Laboratory Assignment 1

EML 4930/5930 Mechatronics II

Due: Wednesday

Purpose:
This lab is intended to introduce you to the measurement tools and techniques necessary for the remainder of this class. It will provide an indispensable experience for using the tools found in this lab. Previous knowledge of low pass filters from Dynamic Systems II and Mechatronics I will be utilized.
***: In lab

Part 1: Resistors

1.1) What is the resistance of the following color codes?

Gray-Red-Orange-Gold	82 kΩ
Green-Blue-Brown-Gold	560 Ω
Orange-Black-Gold-Gold	3.0 Ω
Blue-Gray-Brown-Gold	680 Ω
Gold-Orange-Blue-Green	56 kΩ
Yellow-Violet-Red-Silver	4.7 kΩ
Red-Black-Brown-Silver	200 Ω
Blue-Blue-Blue-Gold	66 MΩ
Green-Brown-Green-Gold	5.1 MΩ
Orange-White-Yellow-Gold	390 kΩ

1.2) What colors correspond to the following resistance values

orange-black-black-gold	30 Ω ± 5%
green-violet-orange-gold	57 kΩ ± 5%
brown-orange-brown-gold	130 Ω ± 5%
orange-black-blue-silver	30 MΩ ± 10%
red-white-orange-gold	29 kΩ ± 5%
violet-gray-black-gold	78 Ω ± 5%
brown-black-orange-gold	10 kΩ ± 5%
orange-orange-orange-gold	33 kΩ ± 5%
yellow-red-black-silver	42 Ω ± 10%
orange-blue-blue-gold	360 MΩ ± 5%

1.3) Label the colors and resistance of 10 resistors of your choosing (2 must be blue high-precision resistors)

COLORS	RESISTANCE
Orange-orange-k-k	330Ω
y-m-k-brown	4.7kΩ
brown-k-b	100Ω
brown-k-o	10 kΩ
o-k-red	3kΩ
o-o-b	330Ω
b-b-o	11 kΩ
b-green-y	150 kΩ
red-m-red	2.7kΩ
o-k-brown	300Ω

Part 2: Capacitors

2.1) What is the capacitance of the following capacitor codes?

153 M	15 nF
103 K	10 nF
0.01 M	10 pF
221 K	220 pF
0.0022 Z	2.2 pF

2.2) Label 10 random capacitors of your choosing; also give the type of capacitor.

DESCRIPTION	CAPACITANCE	TYPE
Black Cylinder	47 µF	electrolytic
	2.2 µF	
	22 µF	
	3.3 µF	
green Cylinder	180 µF	
Blue " "	100 µF	
Red rect. Prism	39 nF	Film
" "	22 nF	" "

'' ''	3.3 nF	'' ''
'' "	10 nF	'' ''

Part 3: The Multimeter

Obtain a multimeter and two probe cables as shown in **figure 1.** Plug the black cable into the hole labeled COM and the red cable into the hole labeled VΩ. The red cable will be used as the positive end for reading voltages, and the black cable will be used as the negative end for the ground. This color scheme will be followed for the rest of the semester for all circuits.

Figure 1. Multimeter and probes

3.1) Familiarize yourself with the symbols found on the dial of the multimeter. *List the functions that the multimeter can perform.* Voltage, resistance, Continuity, Capacitance, diode, Current

3.2) Examine a "wall wart" power supply at home. *What is the orientation of the wall wart connector (what is positive and negative)? What is the output rating for the power supply (on the back of the brick)?*

- No polarization
- 12 V, 2A


Figure 2. Wall wart AC adapter

3.3) Place one probe inside the barrel plug of the power supply. Rapidly touch the other probe to the other barrel plug. *What voltage is measured? How quickly does the meter respond?*

12,63 V

~ 1/2 second

3.4) Using a multimeter, measure the resistance of the first 5 resistors from Part 1.1. Note the difference between theoretical and actual resistance, and determine whether or not it falls within the resistor's tolerance.

Color Code	Labeled Value	Measured Value	Within Tolerance?
Gray-Red-Orange-Gold	82 K	81.6	Yes / No
Green-Blue-Brown-Gold	560	555	Yes / No
Orange-Black-Gold-Gold	3	3	Yes / No
Blue-Gray-Brown-Gold	680	672	Yes / No
Gold-Orange-Blue-Green	56 K	55.7K	Yes / No

3.5) *** Use the multimeter measure the capacitance of the 5 capacitors used in Part 2.1. Note the difference between theoretical and actual capacitance, and determine whether or not it falls within the capacitor's tolerance.

Labeled Value	Measured Value	Within Tolerance?
15 nF	14.82	Yes / No
10 nF	9.98	Yes / No
		Yes / No
		Yes / No
		Yes / No

Couldn't find these

Part 4: Arduino

4.1) Open Arduino on a desktop/laptop and create a new project

4.2) Program the arduino to do the following

- Light up 1 LED when Switch 2 is pressed
- Flash the LEDs with a 0.5 sec delay when Switch 3 is pressed
- Display your name on the LCD screen when Switch 4 is pressed
- Display the value received from the potentiometer when Switch 5 is pressed

Show the completed program to the instructor and turn in a copy of your code.

Part 5: The Oscilloscope and Function Generator ***

Obtain an oscilloscope and a scope probe. Start the calibration procedure for the oscilloscope probes (see **figure 3**) by placing the probe and ground on the stainless-steel lugs in the middle of the scope. The alligator clip on the probe should connect to ground. Connect the BNC connector of the probe to the INPUT terminal of CH1 or CH2. Press the "AUTOSET" button and the oscilloscope will automatically center and magnify the signal to fit the viewing window. A 5V square wave should appear on the screen. Use the trim screw next to the BNC connector to adjust the wave appearance so there is no ringing or overshoot. (Appendix A in *The Art of Electronics* covers the reasons why we calibrate the probe and general procedure.) **Perform the calibration and use the probe with the switch in the 10X position.** A picture of a calibrated oscilloscope probe is depicted in **figure 4**. Note: the exact frequency of the square wave may differ from the 1 kHz label.

Figure 3. Oscilloscope probe

Figure 4. Calibrated oscilloscope

Set up the BK Function Generator. Look over the controls and set it up to produce a triangular waveform output at about 1 kHz and 2.5V. You can change the waveform by pressing the blue shift button and then choosing which waveform you desire (they are shown above the buttons on the top row). To change the Pk-Pk voltage, press the "Ampl/Duty" button and change the voltage shown. To change the frequency, press the "Freq/Period" button and change the frequencey shown. Press the output button to output the signal from the function generator.

Figure 5. Function generator

5.1) Connect the output cable of the signal generator to the cable connected to the oscilloscope and get a steady display. Press the measure button on the oscilloscope. Cycle through the various measurements that are possible on the oscilloscope by pressing the buttons closests to the screen. This can be done by turning the SEC/DIV knob in the HORIZONTAL section. Turn the knob labeled VOLTS/DIV in the VERTICAL section. This knob changes the voltage per square of the grid on the screen. This changes how the signal appears on the oscilloscope but you should note that the measurements of the signal do not change (i.e. Pk-Pk voltage, frequency, etc.). *Output a 1kHz, 1V Pk-Pk sine wave from the function generator and display it on the oscilloscope. Set the oscilloscope window so 3 periods are shown and the wave covers most of the screen. Save a picture of an oscilloscope drawing by inserting a USB flash drive into the front slot and pressing the print button. Attach the picture to your lab.*

5.2) Experiment with the trigger level control. Notice how it sets where in the waveform the display begins. You should be able to move the starting point of the trace (the arrow at the top center of the screen) back and forth along the ramp in the triangular wave. Notice how the trace disappears as the level is set above or below the top and bottom of the waveform. The trigger level is set based on the input scale, so if you need to change the scale, you will probably also need to adjust the trigger level. *Use the trigger to set the peak of the triangle wave at the center of the oscilloscope screen. Save a picture and turn it in with your lab.*

5.3) *When would you use an oscilloscope as opposed to a multimeter?*

O-Scope is better for time-varying Signals as the multimeter can not display transient info

5.4) *What are the advantages of each?*

- Multimeter is simple to use & portable
- O-Scope can provide a variety of info simultaneously & can show time-varying data

Part 6: Low-Pass Filter ***

Create a 1 kHz, 5V square wave using the function generator and feed it into an RC-circuit.

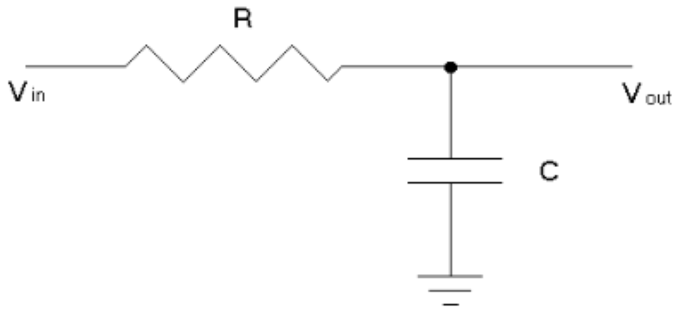

Figure 6: Low-Pass Filter

$$\tau = RC$$
$$f_c = 1/(2\,\text{pi} * RC)$$

6.1) Determine the values necessary for the RC Circuit to filter the peak-to-peak voltage of the original signal to 1/10, 1/4, and 1/2 its original value. Submit a print screen of all these curves and include which resistors and capacitors were chosen for these filters

	Resistance (R)	**Capacitor (C)**	**V_{out} (Pk-Pk)**	**Time Const. (τ)**	**Corner Freq. (f_c)**
0.1 V_{in}	154k	0.01 μF	0.5	1.54 mS	100.5 Hz
0.25 V_{in}	66k		1.25	.66 mS	250 Hz
0.5 V_{in}	33k		2.5	.33 mS	500 Hz