Supplement to the Traditional Lab Manual for Experiment #2
Hands-On Version of Experiment #2 Only!

Sections 1 and 2 – Read these in their entirety.

Section 2 equation (5) – since we are using a 0 to 2 volt square wave in sections 4.3, 4.4, and 4.5 instead of the original 0 to 1 volt square wave that was specified in the traditional lab manual, equation (5) must be multiplied by 2.

Section 3 – Prelab Exercises – Complete 3.1 and 3.2. Again, remember to multiply equation (5) by 2 for 3.2.

Section 4 – Experiments

The equipment for our hands-on experiment is completely different. It includes

Instrustar USB Oscilloscope/Function generator Model 205B
XL830L DMM
Variable Resistor (screwdriver adjusted)
Resistor
Capacitor
Inductor
Camera/Copy Screen Command to Record Waveforms

4.1 Function Generator Resistance – Delete and change to:

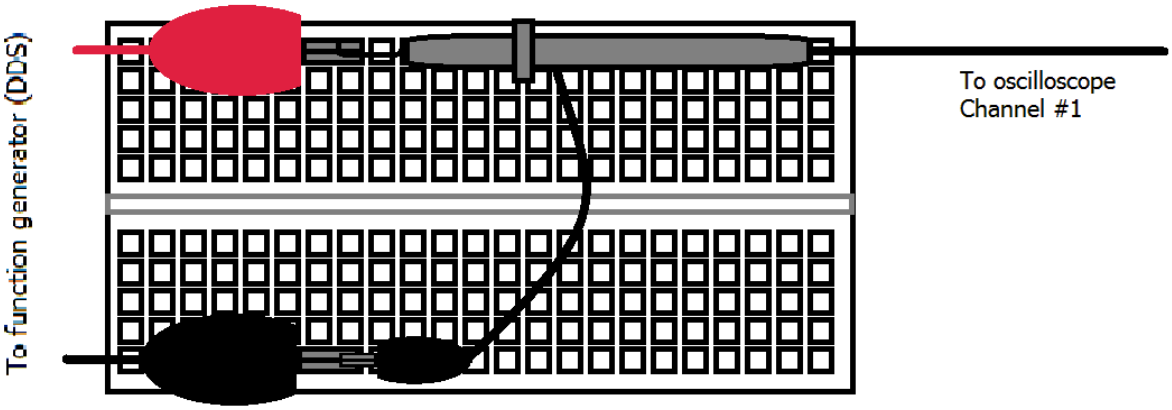
The internal impedance (resistance) of the function generator will affect the damping of an RLC circuit to which it is connected. Measure the resistance in the following way:

a- Connect the function generator to oscilloscope Channel #1 using the test probe set for a X1 multiplier. Generate a **5 Vp-p**, 1 kHz sine wave with no DC offset (so the sine wave should go from -2.5V to + 2.5 V). Look at the voltage measurements at the bottom of the screen and set the voltage and offset as close as you can by adjusting the two knobs on the rear of the USB oscilloscope.

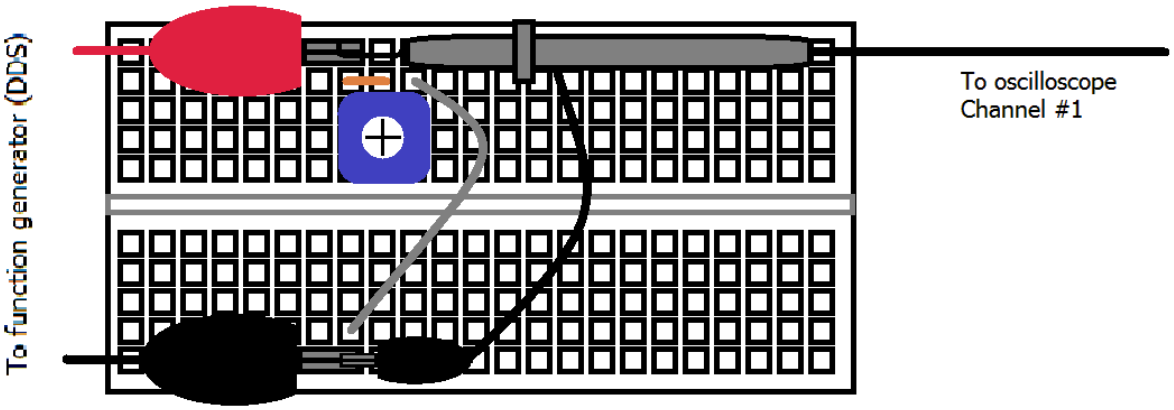
b- Connect a variable resistance load using the 500Ω variable resistor to the generator output, thus forming a voltage divider. Watch my video on variable resistors and preset the resistor so it has a resistance of approximately 500Ω initially. The divider is formed by the first resistance inside the function generator, and the second resistance being the variable resistor. The scope is connected to the center node of the divider formed by the external and internal resistances.

Supplement to the Traditional Lab Manual for Experiment #2
Hands-On Version of Experiment #2 Only!

4.1 a. Function generator resistance
Initially set the function generator to output a 5 Vp-p, 1KHz sine wave.



4.1 b. Set the variable resistor to approximately 500 ohms initially then reduce the resistance until you get a 2.5 Vp-p sine wave. Then disconnect the oscilloscope and function generator and measure the variable resistor with your DMM.

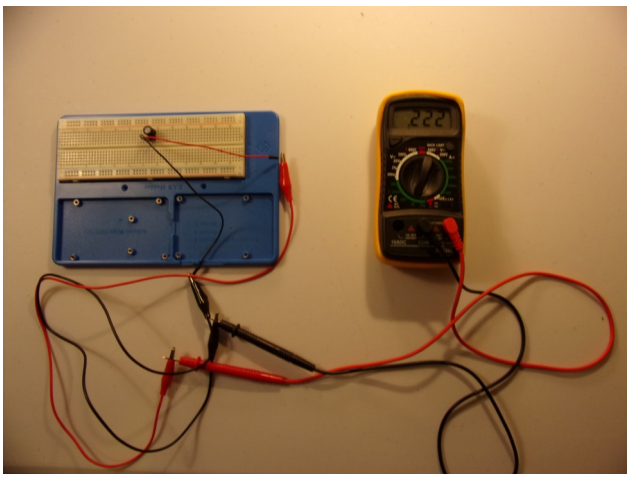


Supplement to the Traditional Lab Manual for Experiment #2
Hands-On Version of Experiment #2 Only!

Adjust the variable resistor (decrease its resistance) until the measured voltage falls to one-half the open circuit value which will be **2.5 Vp-p**. At this point the two resistances of the voltage divider must be equal. Therefore, the resistance of the variable resistor should now be equal to the internal resistance of the function generator. Turn off the function generator (DDS), disconnect both it and the oscilloscope probe from the circuit, and then measure the variable resistor's new resistance using the DMM set on the 2KΩ scale. You should get approximately 200Ω. Record this value.

4.2 Inductor Internal Resistance – Delete and change to:

Use the DMM, set on the 2KΩ scale, to measure the internal DC resistance of the 100mH inductor. Again, you should get approximately 200Ω. Record this value.

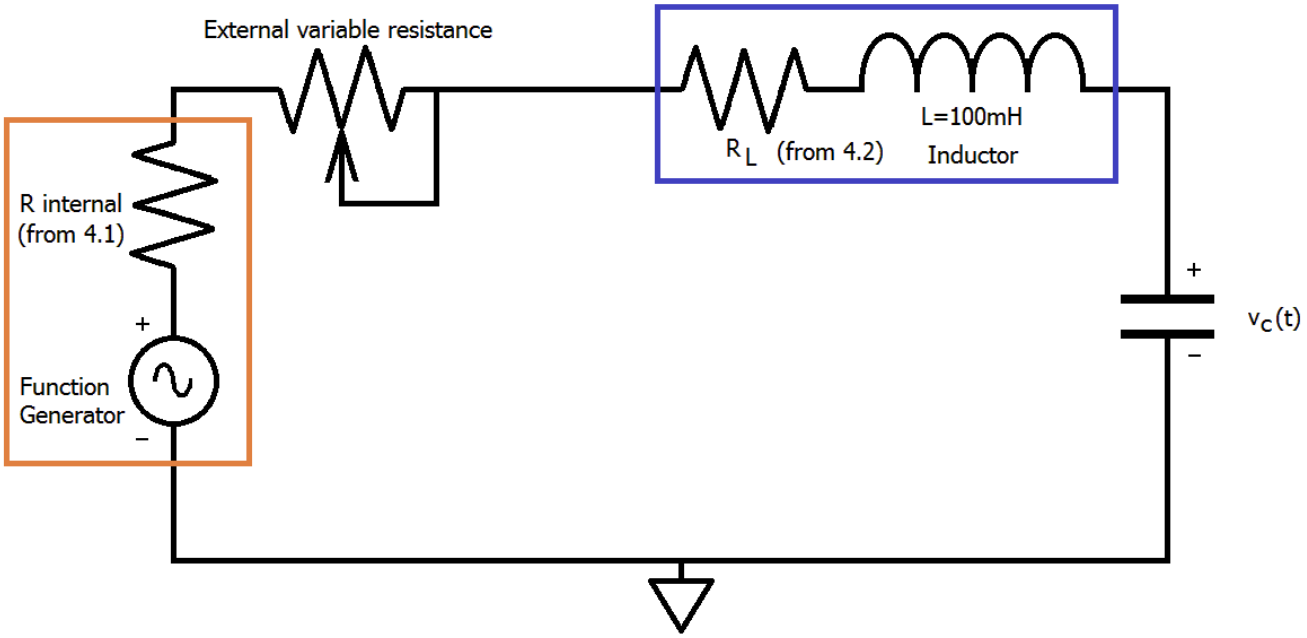


Supplement to the Traditional Lab Manual for Experiment #2
Hands-On Version of Experiment #2 Only!

4.3 Step Response of RLC Branch – Delete and replace with:

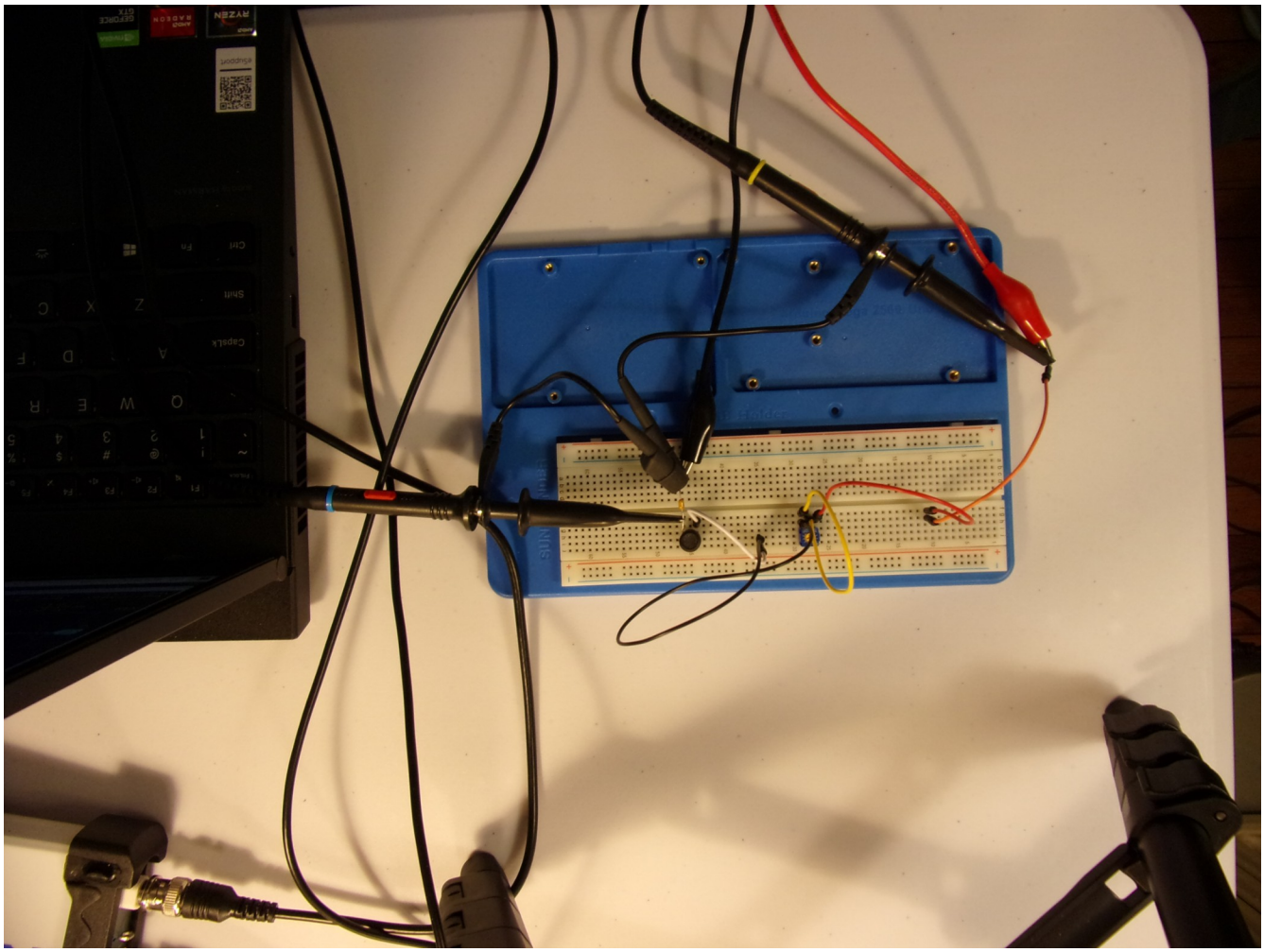
Modify the resistance values calculated in section 3.1 by subtracting the function generator's internal resistance and the inductor's internal resistance. These new modified resistance values represent the actual external resistance values that you need to add to get the desired damping coefficients. Use an external variable resistor with a full scale resistance of 500Ω, 1000Ω, or 10kΩ (from your PEE1 parts kit) and adjust it for the needed external resistance to get the desired damping coefficients in sections 4.3 and 4.4. For section 4.3 use the 500Ω variable resistor included with the PEE2 lab kit.

Arrange a series RLC series circuit (as shown below) using the values calculated for ζ = 0.1 in Section 3.1 (Pre-lab exercise). Connect the + side of C to the oscilloscope channel #2 input using a probe set for a X1 multiplier. Keep channel #1 connected to the function generator as it will provide a stable trigger for the scope.



Set the oscilloscope sweep rate to 100 μs/div, and vertical sensitivity to 500mV/div. Set the square wave output from 0 volts (as close as you can get to 0 volts but it will be hard to get it perfect with this equipment) to 2 volts (this high level voltage must be adjusted as close to 2 volts as possible). With the square wave input to the circuit, set f = 200Hz and observe the typical oscillatory response to a step input. (Instead of a step input, a square wave of low enough frequency is used so that the repetitive wave form of the capacitor voltage can be easily plotted on the scope). Check the function generator voltage so that the steady state value (high level) of the capacitor voltage is 2 volts corresponding to the particular solution for a step input. Copy the waveform using screen capture or photograph the screen with your cellphone. Include this photo in your lab report.

Supplement to the Traditional Lab Manual for Experiment #2
Hands-On Version of Experiment #2 Only!



Note1: The horizontal triggering position may be used to reposition the oscilloscope trace to the left or right of the display just showing the ½ cycle of interest.
Note 2: The (horizontal) sweep rate and the (vertical) sensitivity can be adjusted to during this experiment to get detailed plot on the screen. The values given in this manual should be used as a general guide. They are not an absolute requirement.

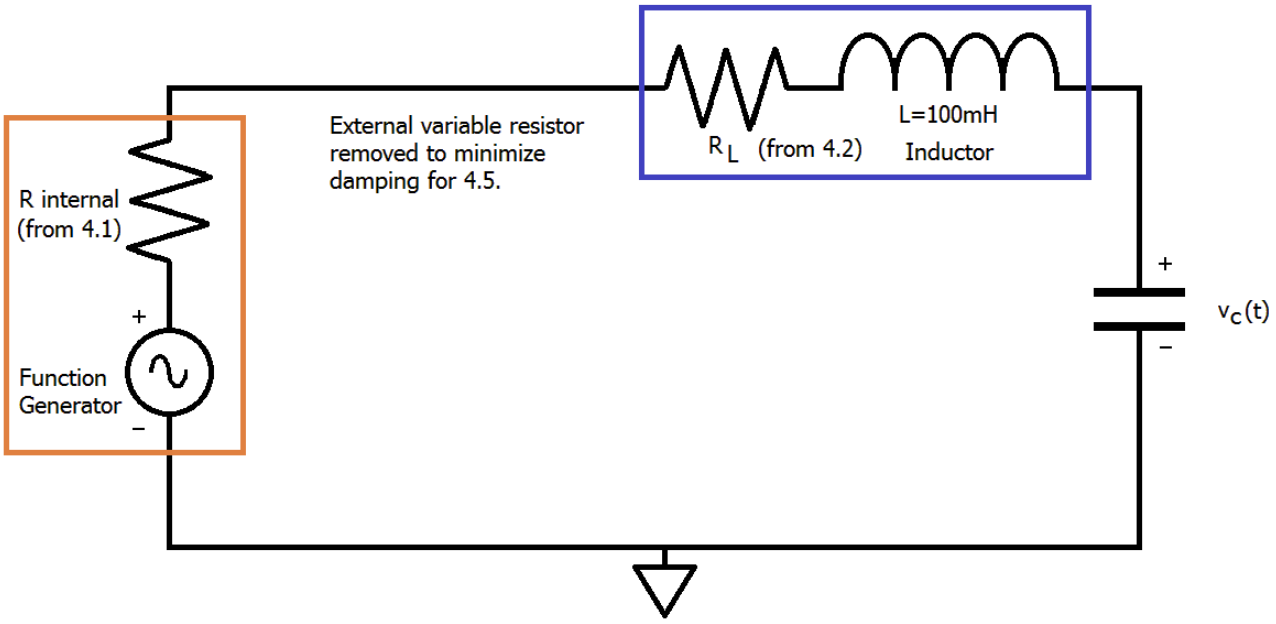
4.4 Measurement of Peaks – Delete and replace with:

Use the cursors on the oscilloscope to measure the values of the maxima and the minima based on a 2 volt step input. Set the cursors to measure voltage (they should be horizontal on the screen). Measure the voltage of the first maximum, first minimum, and second maximum. Repeat 4.3 for different values of ζ, fill all the values in Table 1 and compare with the theoretical values that were calculated in the pre-lab exercise 3.2. In each case, copy or photograph the waveform and include it in your lab report.

Supplement to the Traditional Lab Manual for Experiment #2
Hands-On Version of Experiment #2 Only!

4.5 Find the Natural Frequency fo – Delete and replace with:

Change the sweep to 100 usec/div and reduce damping as much as possible by removing the external resistance (see the schematic below). Notice that the period of the oscillation is close to 200μs which corresponds to the natural frequency fo used to determine the L and C values. Measure the period for two full sine waves divide this value by 2 and take the reciprocal to find fo. Record and compare this to the theoretical value found using the formula $f_0 = \frac{1}{2\pi\sqrt{LC}}$.



5. Report

5.1 and 5.2 – Delete.

5.3 Note that formula (5) in section 2 must be multiplied by 2 because we are now using a 2 volt step input.

5.4 Include a simple summary at the end of your report (as asked for in the ECE Lab Report Cover Page). The summary should be short (just one small paragraph is sufficient) and in your own words.