ENSC220 (2015-3)

Laboratory 4.1 – First Order Circuits

(Due Oct 30th 2015, 11:00pm)

Read the inductor making tips handout

In part-1 of this lab session you will

1. Construct an air core inductor
2. Conduct step and natural response to experimentally determine the time constant and verify the inductance
3. Conduct step and natural response on a R-C circuit

1. Construction of the tapped inductor

You will be supplied with #26 AWG enameled wire (0.0170" diameter) and a 5" piece of nominal 3/4" (actual O.D.1-1/16") plastic pipe to construct your inductor. Wind the wire neatly and tightly around the plastic pipe. For every **40** turns you introduce a twisted wire loop to create a tap. **Use all the wire given to you.** **(Do not stop after 6 taps. The inductor can have more than 6 taps)** Figure 1 shows the illustration of the inductor we want you to construct. Fred will be giving a detailed instruction on coil construction.

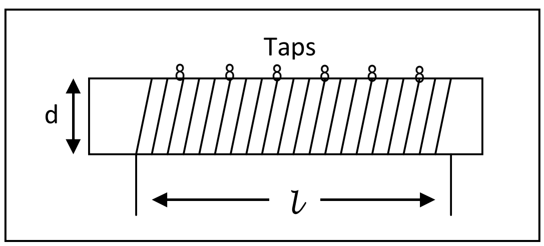


Figure 1. Inductor illustration

Using the emery paper given, remove the insulating enamel gently at the both ends of the coil wire and also at the taps. Solder a small piece of wire to the ends of the coil wire as well as the taps. This will allow you to connect the coil to your bread board for experiments. Using a marker pen, label one end of the coil. This will serve as a reference to identify the coil terminals.

2. Calculation and measurement of Inductance

The inductance L of an air-core inductor is approximated by:

$$L = \frac{d^2 n^2}{18d + 40l}$$

where:

L = inductance (measured in μH)

d = coil diameter (inches)

l = coil length (inches)

n = number of turns.

a) Calculate the inductances of the tapped inductor using the above formula and record

b) Using the LCR bridge (located on top of the component rack) measure the inductances and record. When you use the LCR bridge, set the selection to LC, series and 1kHz.

c) Construct a R-L circuit as shown in Figure-2. Choose a resistor value around 300 Ω, measure the exact resistance value using DMM.

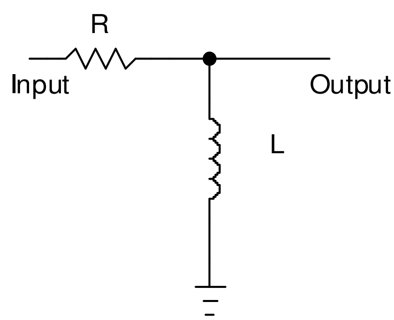


Figure 2: Schematic of a R-L test circuit

Input a square wave to simulate a step/natural response. Observe the input and output using the two channels of the oscilloscope. Choose the FnGen amplitude no more than 5V peak (10V Pk-Pk). Adjust the frequency of the input so that you obtain an output waveform that clearly shows the charging and discharging characteristics. Adjust the scope display to show a full discharging cycle waveform.

d) Using the cursor measurement feature measure the time constant of the R-L network.

e) Using the R-L circuit time constant formula calculate the inductance value and compare with the inductances calculated/measured using other techniques.

3. R-C circuit experiment

Construct a R-C circuit as shown in Figure 3. Use 1nF capacitor and a 10K resistor to construct the circuit. Measure the exact values of the resistance using the DMM and the capacitance using LCR bridge. Input a square wave and adjust the frequency to obtain the output waveform that clearly shows the charging and discharging characteristics. From the waveform determine the time constant and verify the value of the capacitance.

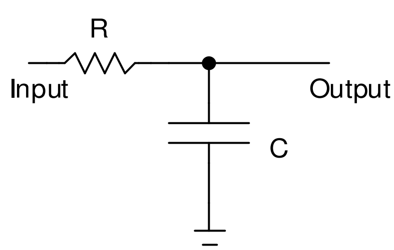
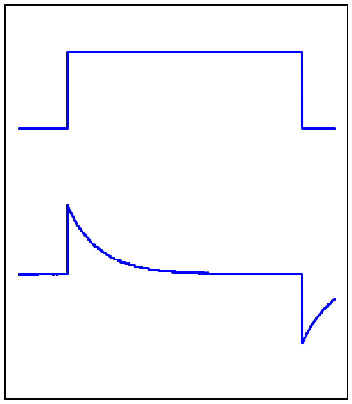
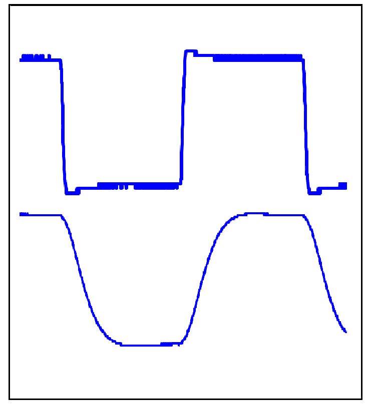
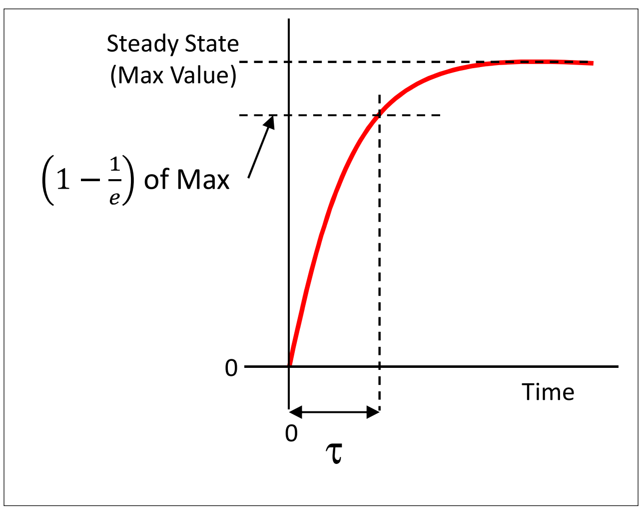


Figure 3: Schematic of R-C test circuit

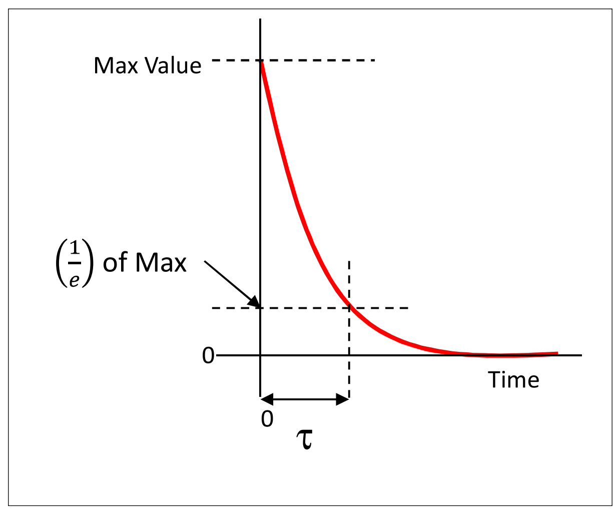




Typical scope waveforms from which you can determine time constant. Adjust the frequency of the input until you observe the charging and discharging wave shape clearly, as illustrated above.



Charging Cycle

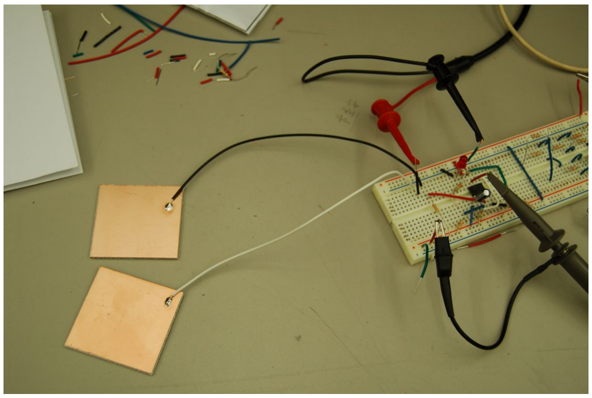


Discharging Cycle

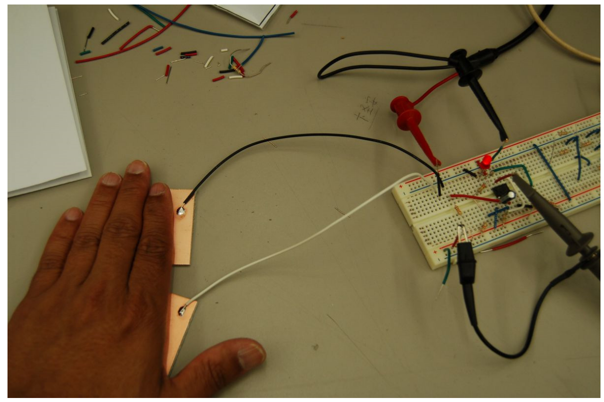
(Part 2) Laboratory 4.2 – Touch Switch

(You have to demonstrate this touch switch before Oct 30th)

In this lab exercise, you have to demonstrate a touch switch. A pair of copper plates, or simply a pair of wires are used as touch-pads and when you place your hand on it a light emitting diode should glow. See the illustration below:



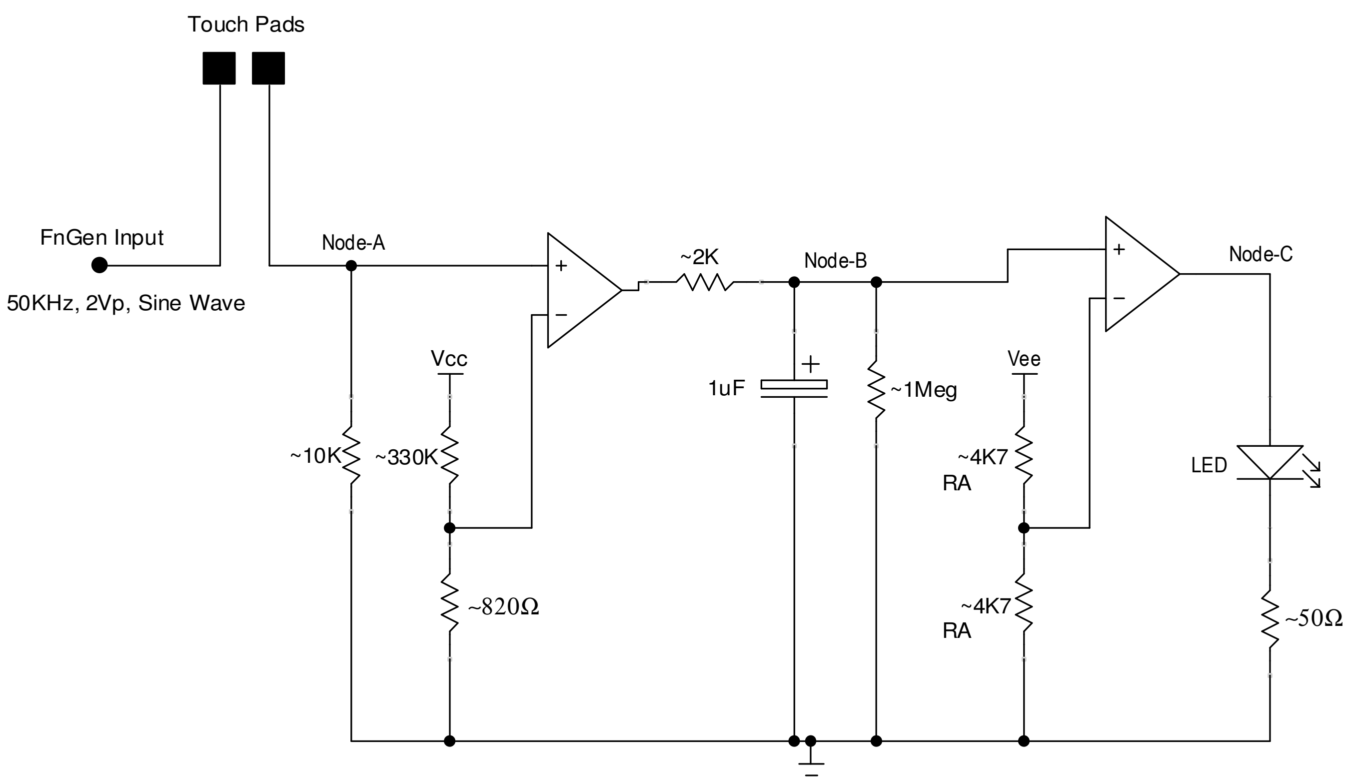
Touch switch circuit with touch-pads



LED is ON sensing the touch

If the copper plates are not available just touching the wire-tips should give the touch signal.

The schematic of the touch switch is shown below. You can use a pair of wires as touch pads and you can grasp the ends of the wires to simulate the touch when you test your circuit. You have to collect a set of waveform data, see the Lab4 Record. Demonstrate your touch switch to the instructor or one of the TAs.



Resistors RA should have same values

Schematic of the touch-switch circuit. OPAMPS are powered using ± 10V. Note the polarity of the 1µFD capacitor. The resistor values are approximate. You do not need the exact indicated values for the resistors. You may pick a value close to the indicated number. For example 26K will work instead of 10K resistor at the input. A 270K will work instead of 330K for the potential divider. If the red bin is empty, you should be able to find an assortment from the blue bin.

Wiring Suggestion for touch switch