LAMAR UNIVERSITY
CIRCUITS LABORATORY

EXPERIMENT 8:

Low Pass and High Pass Filters

Objectives:

- Study the characteristics of passive filters by obtaining the frequency response of Low Pass RC filter and High Pass RL filter

Equipment:

- Resistors (1.1KΩ)
- Capacitor (1µF)
- Inductor (33 mH)

Theory:

The impedance of an inductor is proportional to frequency and the impedance of a capacitor is inversely proportional to frequency. These characteristics can be used to select or reject certain frequencies of an input signal. This selection and rejection of frequencies is called filtering, and a circuit which does this is called a *filter*.

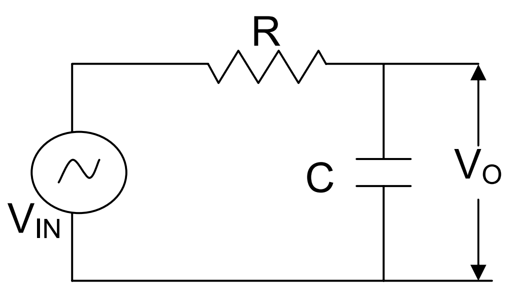

Figure 1: Low Pass RC filter.

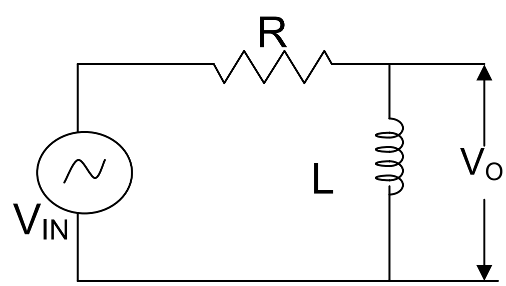

Figure 2: High Pass RL filter.

If a filter passes high frequencies and rejects low frequencies, then it is a high-pass filter. Conversely, if it passes low frequencies and rejects high ones, it is a low-pass filter. Filters, like most things, aren't perfect. They don't absolutely pass some frequencies and absolutely reject others. A frequency is considered passed if its magnitude (voltage amplitude) is within 70% (or $1/\sqrt{2}$) of the maximum amplitude passed and rejected otherwise. The 70% frequency is called corner frequency, roll-off frequency or half-power frequency.

The corner frequencies for RC filter and RL filter are as follows:

For RC filters:

$$f_c = \frac{1}{2 \pi R C} \tag{1}$$

For RL filters:

$$f_c = \frac{R}{2 \pi L} \tag{2}$$

Frequency Response: It is a graph of magnitude of the output voltage of the filter as a function of the frequency. It is generally used to characterize the range of frequencies in which the filter is designed to operate within.

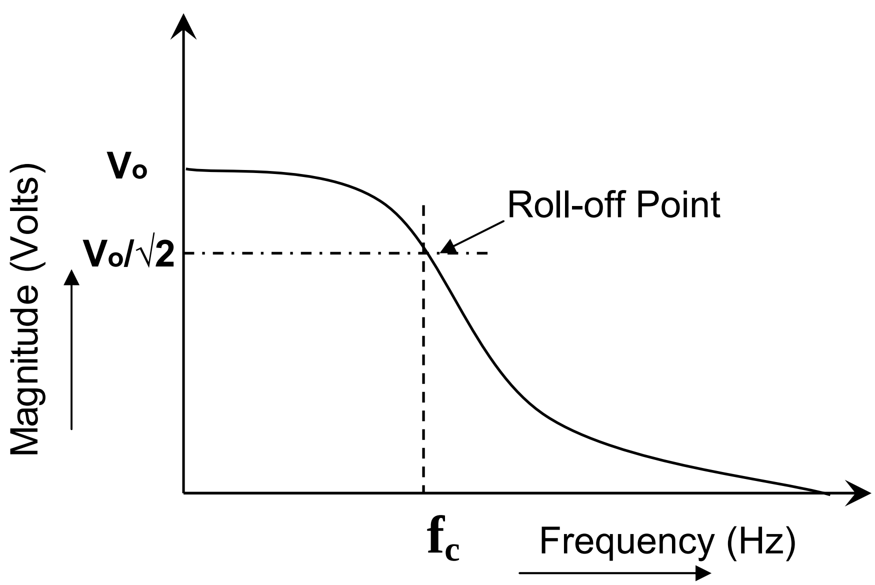

Figure 3: Frequency Response of a typical Low Pass Filter with a cut-off frequency f_c

Procedure:

A. Low Pass RC Filter:

1. Set up the circuit shown in the **Figure 1** with the component values R = 1.1 kΩ, C = 1μF. Switch on the Elvis Power Supply.
2. Select the Function Generator from the NI-ELVIS Menu and apply a 4 V peak-peak Sinusoidal wave as input voltage to the circuit.
3. Select the Oscilloscope from the NI-ELVIS Menu. Make sure the Source on Channel A, function out on Channel B, Trigger and Time base input boxes are properly set.
4. Start with a low frequency i.e. 50 Hz and measure output voltage peak to peak from the scope screen. It should be same as the signal generator output. Vary the frequency of the FGEN panel until you see roughly $0.7V_{fgen}$ peak to peak
5. Compute the 70 % of Vp-p and obtain the frequency at which this occurs on the Oscilloscope. This gives the cut-off (roll-off) frequency for the constructed Low Pass RC filter.

B. High Pass RL Filter:

1. Set up the circuit shown in the **Figure 2** with the component values R = 1.1 KΩ, L = 33mH and Switch on the Elvis Power Supply.
2. Repeat steps 2 and 3 as in Part A to obtain the frequency response on the Oscilloscope.
3. Start with a high frequency (20 KHz) and measure the output voltage peak to peak from the scope screen. It should be same as the signal generator output. Adjust the time base of the scope accordingly to observe this.
4. Compute the 70 % of Vp-p and obtain the frequency at which this occurs on the Oscilloscope. This gives the cut-off (roll-off) frequency for the constructed High Pass RL filter.

Questions for Lab Report:

1. Compute the Cut-off frequencies for the RC and RL filter using the formulae in equations (1) and (2). Compare these theoretical values to the ones obtained from the experiment and provide suitable explanation for any differences.