**LAMAR UNIVERSITY**
**CIRCUITS LABORATORY**

**EXPERIMENT 9:**

# Band Pass Filters

## Objectives:

1. Construct a Band Pass Filter by cascading a low pass filter and a high pass filter.
2. Obtain the frequency response of the filter and learn using the Bode Analyzer.

## Equipment:

1. Resistors (1200Ω)
2. Capacitors (0.01μF)
3. Inductors (33 mH)

## Theory:

A Band Pass Filter allows a specific frequency range to pass, while blocking lower and higher frequencies. It allows frequencies between two cut-off frequencies while attenuating frequencies outside the cut-off frequencies.

A good application of a band pass filter is in Audio Signal Processing, where a specific range of frequencies of sound are required while eliminating the rest. Another application is in the selection of a specific signal from a range of signals in communication systems.

A band pass filter may be constructed by cascading a High Pass RL filter with a roll-off frequency $f_L$ and a Low Pass RC filter with a roll-off frequency $f_H$, such that

$$f_L < f_H$$

The Lower cut-off frequency is given as:

$$f_L = \frac{R}{2 \pi L} \quad (1)$$

The higher cut-off frequency is given as :

$$f_H = \frac{1}{2 \pi R C} \quad (2)$$

The Band Width of frequencies passed is given by:

$$BW = f_H - f_L$$

Thus, all the frequencies below $f_L$ and above $f_H$ are attenuated and those in between are passed by the filter.

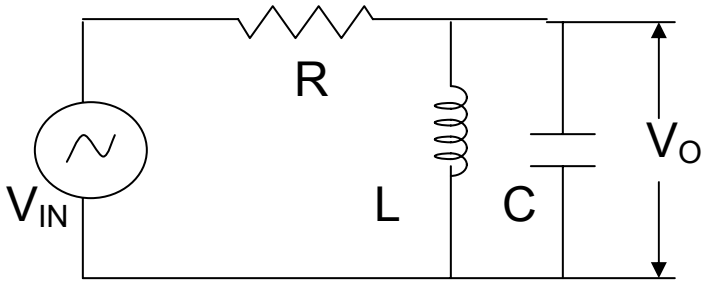


**Figure 1: Circuit Diagram for a Band Pass Filter.**

**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 shows a typical frequency response of a Band Pass filter.

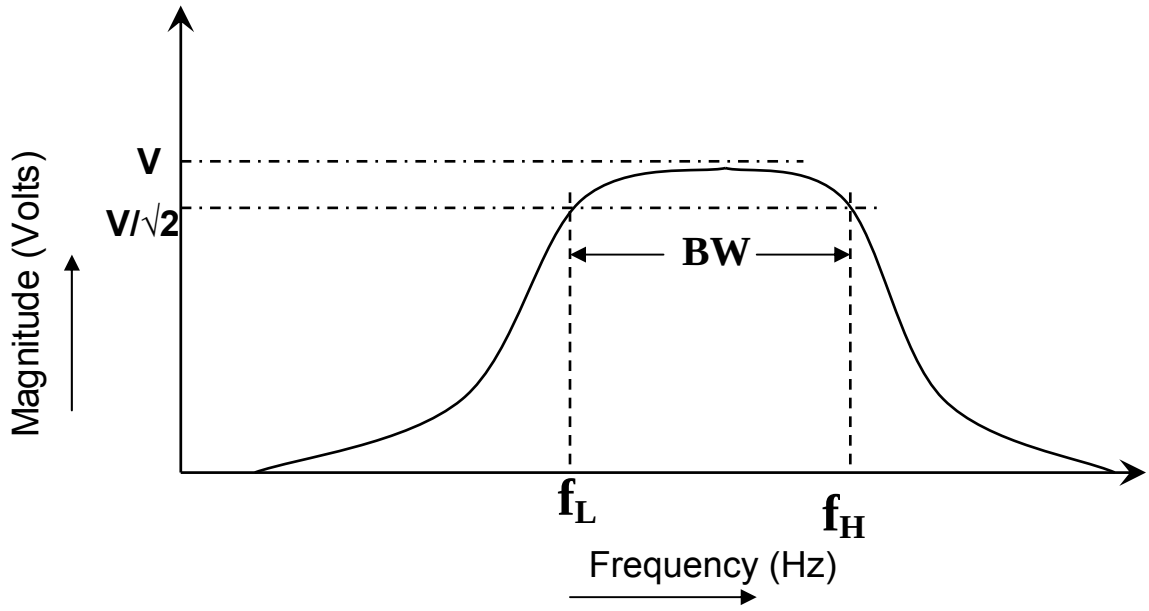


**Figure 2: Frequency response of a Band pass filter.**

## Procedure:

1. Set up the circuit shown in the **Figure 1** with the component values R = 1200Ω, C = 0.01μF and L = 33mH. 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, Source on Channel B, Trigger and Time base input boxes are properly set.
4. Compute the 70 % of Vp-p and obtain the frequencies at which this occurs on the Oscilloscope.(Note that it occurs twice on the band pass filter , near Lower cutoff and near upper cutoff). This gives the cut-off (roll-off) frequencies for the constructed Band Pass filter.

## Using the Bode Analyzer:

The Bode Analyzer is used to analyze the frequency response of an AC circuit. It displays the Bode Plots which are the magnitude and the phase versus the frequency of a given network. The procedure is as follows:

1. Close all the current panels which are open and launch the bode analyzer from the NI-ELVIS menu.
2. Connect the outputs of the circuit to $ACH0^{+}$ and $ACH0^{-}$ instead of CH $B^{+}$ and CH $B^{-}$.
3. Connect the Function Generator as input to $ACH1^{+}$ and GND to $ACH1^{-}$, while keeping the existing connections of the FGEN to the Input of the circuit.
4. From the Bode Analyzer, set the scan parameters as follows (Refer to Figure 3):

   Start: 100 (Hz)
   Stop: 35000 (Hz)
   Steps: l0 (per decade)

5. Press **Run** and observe the Bode plot for the constructed Band Pass filter.
6. Record the results and save the Bode Plot using **Alt + PrintScrn** Key.

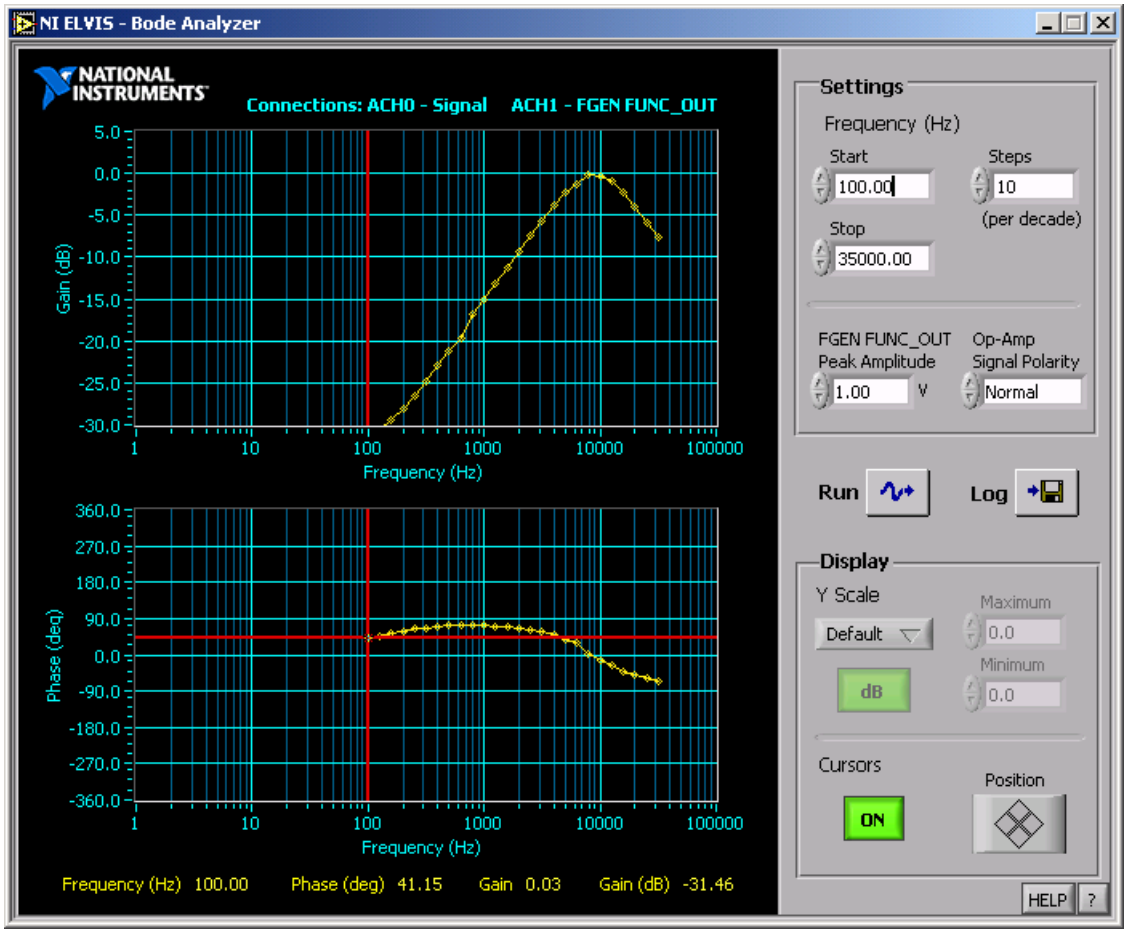


**Figure 3: Bode Analyzer Settings**

## Questions for Lab Report:

1. Compute the cut-off frequencies for each Band Pass filter constructed 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.
2. Graph the Frequency Response for each filter built in the lab. (Use the values recorded in the tabular column and graph with the frequency on a logarithmic scale). Compare this to the response obtained from the Bode Plot and comment.