Experiment #10 Implementation of Active Filters

Objective
To study and implement the active low pass, high pass and band pass filters.

Equipment
Function generator with probes
DMM
Dc supply
Oscilloscope
Trainer IT-2006
Resistor

Theory

Filters are electronic circuits which perform signal processing functions specially removing unwanted frequency components from signal. Active filters use RC circuits to filter out desired frequency components along with op Amp. In passive filters only RC circuit is used so when they are ganged up in cascading, they give loading effect. To overcome loading effect op Amp are used in active filters.

10.1 Active low pass filters

An active low pass filter is one that passes frequency from DC to AC and significantly attenuates all other frequency. The critical frequency of 1st order low pass filter is given in (10.1),

$$f_c = \frac{1}{2\pi RC} \qquad (10.1)$$

Its voltage gain is given by

$$A_v = \frac{R_f}{R_A} + 1 \qquad (10.2)$$

In the circuit shown in Figure 10.1, input is applied at input resistor and output is taken from capacitor and fed to operational amplifier.

Circuit Diagram

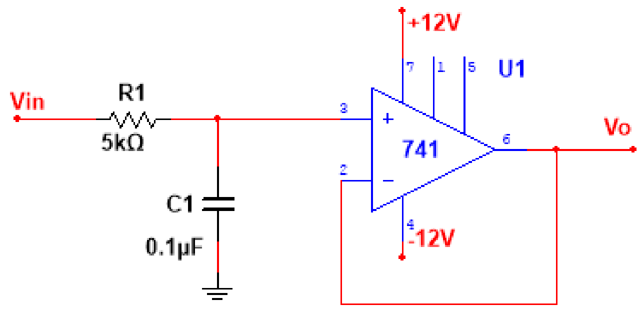

Figure 10.1: Active Low Pass Filter

Procedure

1. Connect circuit diagram according to given circuit shown in Figure 10.1.
2. Adjust frequencies of input voltages Vin using function generator and apply on civet and analyze waveform from oscilloscope.
3. Determine critical frequency fc and draw a graph between Vo and f.

Observations

f(Hz)													
Vo(p-p)													

10.1.1 Second order low pass filter

In second order low pass filter as shown in Figure 10.2, two RC circuit are ganged up to provide a roll of -40dV/decade. It is known as voltage-controlled voltage source filter. Its critical frequency is given in (10.3).

Circuit Diagram

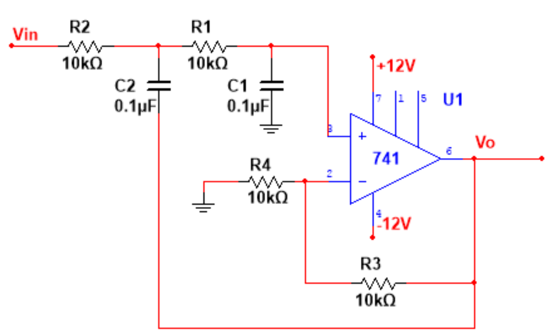

Figure 10.2: Second Order Active Low Pass Filter

Procedure

1. Connect circuit diagram according to given circuit shown in Figure 10.2.
2. Adjust frequencies of Vin using function generator and apply on circuit and analyze waveform from oscilloscope
3. Determine critical frequency fc by using (10.3).

$$f_c = \frac{1}{\sqrt{R_A R_B C_A C_B}} \qquad (10.3)$$

4. Draw graph between Vo and f.

Observations

f(Hz)												
Vo(p-p)												

10.2 Active high pass filters

An active high pass filter is one that significantly attenuates or rejects all frequency below fc and passes all frequencies above fc. Its critical frequency is same as given in (10.1). In the circuit shown in Figure 10.3, the input is given at capacitor and output is taken from resistor and fed to op Amp.

Circuit Diagram

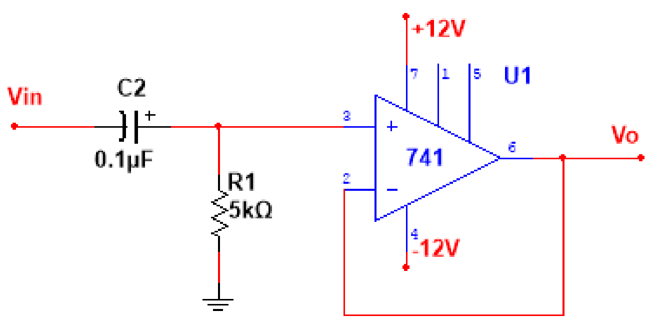

Figure 10.3: Active High Pass Filter

Procedure

1. Connect circuit diagram according to given circuit shown in Figure 10.3.
2. Adjust the frequencies of Vin using function generator and apply on circuit and analyze waveform from oscilloscope.
3. Measure Vo and record in table.
4. Determine cut off frequency fc by using (10.1).
5. Draw the graph between Vo and f.

Observations

f(Hz)											
Vo(p-p)											

10.2.1 Second order high pass filter

In this filter, two RC circuit Cascades with op Amp to provide roll off of -40dB/decade. The positioning of resistor and capacitor is opposite to low pass filter. It's critical frequency is same as given in (10.3).

Circuit diagram

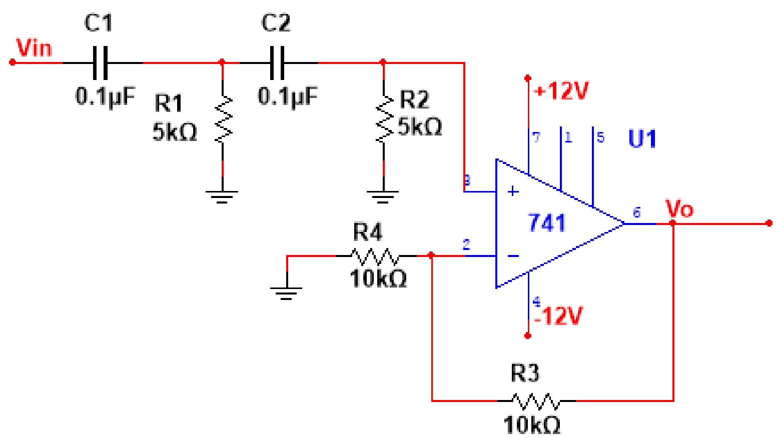

Figure 10.4: Second Order Active High Pass Filter

Procedure

1. Connect circuit diagram according to given circuit shown in Figure 10.4.
2. Adjust frequencies of Vin using function generator and apply on circuit and analyze waveform from oscilloscope.
3. Measure Vo and record in table.
4. Determine cut off frequency fc by using (10.3).
5. Draw the graph between Vo and f.

Observations

f(Hz)											
Vo(p-p)											

10.3 Active band pass filter

Active band pass filters allow to pass all the frequencies bounded by a lower frequency limit and an upper frequency limit and reject all others lying outside this specified band. Simple active band pass filter is made by cascading a single active low pass and a single active high pass filter. It's roll off is-40dB/decade. The critical frequency if each filter is chosen so that the response curves overlap sufficiently. The lower frequency of pass band is critical frequency of high pass filter.

$$f_{c1} = \frac{1}{2\pi\sqrt{R_{A1}R_{B1}C_{A1}C_{B1}}} \qquad (10.4)$$

The upper frequency of pass band is critical frequency of low pass filter is given by.

$$f_{c2} = \frac{1}{2\pi\sqrt{R_{A2}R_{B2}C_{A2}C_{B2}}} \qquad (10.5)$$

Circuit Diagram

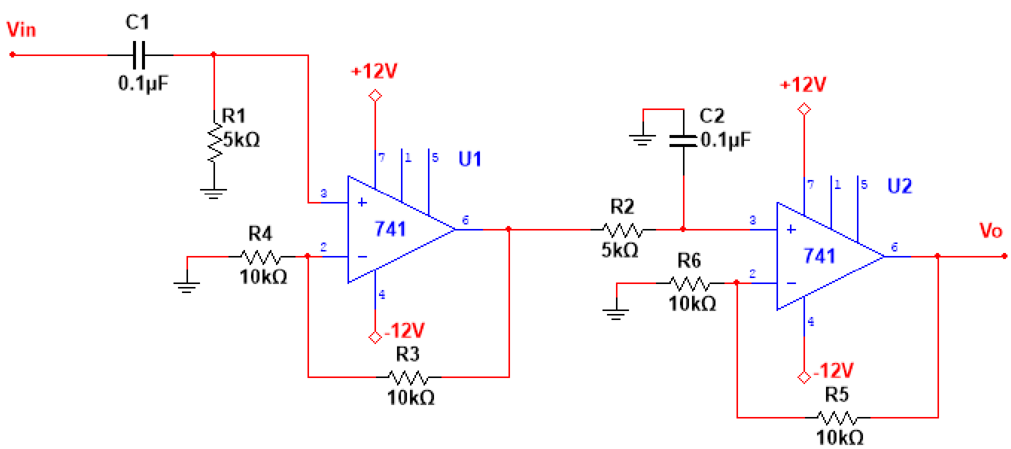

Figure 10.5: Active Band Pass Filter

Procedure

1. Connect circuit diagram according to given circuit shown in Figure 10.5.
2. Adjust frequencies of Vin using function generator and apply on circuit and analyze waveform from oscilloscope.
3. Measure Vo and record in table.
4. Calculate f_{c1} and f_{c2} and BW.
5. From the values of the table draw a graph between frequency and voltage Vo.

Observations

f(Hz)												
Vo(p-p)												

Conclusion