Daffodil International University (DIU)
Department of Electrical and Electronic Engineering

EEE 422: Measurement and Instrumentation Laboratory

EXPERIMENT NO: 11

NAME OF THE EXPERIMENT: DESIGN OF AN ACTIVE LOW PASS BUTTERWORTH FILTER

Objective:

The objective of this experiment is to design a 3rd order low-pass Butterworth filter which is usually built by cascading a -40dB/decade low-pass filter with a -20dB/decade to provide an overall roll-off of -60dB/decade.

Theory:

The Butterworth filter is a type of signal processing filter designed to have as flat a frequency response as possible in the pass-band so that it is also termed a maximally flat magnitude filter. A low-pass filter is a filter that passes low-frequency signals but attenuates (reduces the amplitude of) signals with frequencies higher than the cutoff frequency. The actual amount of attenuation for each frequency varies from filter to filter. It is also called a high-cut filter, or treble cut filter when used in audio applications.

The low-pass filter is built using one low-pass filter of -40dB/decade cascaded with another of -20dB/decade to give an roll-off of -60dB/decade. The overall closed loop gain is the gain of the first filter times the gain of the second filter. That is

$$A_{CL} = \frac{Vo}{Vin} = \frac{Vo1}{Vin} \; x \; \frac{Vo}{Vo1}$$

The cut-off frequency of the active 3rd order low-pass filter is given by

$$fc = \frac{1}{2\,\pi\,R\,C3}\,.$$

At fc, A_{CL} = 0.707= -3dB

Circuit Diagram:

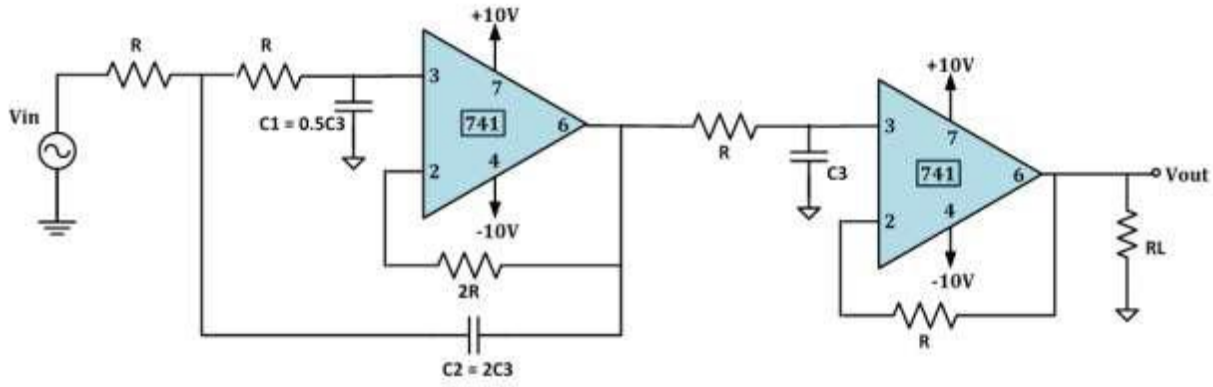

Figure 1: Active Low Pass Butterworth Filter

List of Equiment:

1. Resistances
2. Capacitors
3. Op-amps (IC 741)
4. DC voltage source (+10/-10 V DC)
5. Signal Generator
6. Voltmeter/Multimeter
7. Connecting cables, wires etc.

Procedure:

1. Choose the cut off frequency fc or ωc.
2. Choose a convenient value for C3 between 0.001uF and 0.1uF.
3. Calculate $R = 1/(\omega c\ C3)$.
4. Connect the circuit as shown in figure 1 with Vin= 1V.
5. Vary the frequency from 500Hz to 5kHz by changing the value of R and C.
6. Plot the frequency response for the low-pass filter.

Report:

1. Mention two applications of Butterworth filter.

2. Compare the frequency response of Butterworth filter with Elliptical filters and Chebyshev filters.

3. What is the difference between and active and passive filters?

4. For -60dB/decade Butterworth low-pass filter as shown in figure 1, determine the values of C1, C2 and R for a cut-off frequency of 1kHz. Consider C3= 0.01 uF.