Electrical Engineering Department
Network Lab.

Active low pass filters

Objective: - To familiarize with 2nd order Sallen Key active Low pass filters and to measure their frequency responses.

Theory :

A typical circuit diagram of a 2nd order Sallen key low pass filter is shown in Figure.

With $R_1 = R_2 = R$ and $C_1 = C_2 = C$ the transfer function between the input and the output can be expressed as :

$$\frac{V_0(s)}{V_1(s)} = \frac{K}{1+(3-K)RC_s + R^2C^2s^2} \text{ Where } K = 1 + \frac{R_f}{R_1}$$

The above expression clearly shown a low pass characteristics of the filter with d.c gain = K, cut off frequency $f_0 = \frac{1}{2\pi RC}$ and the *Q-factor,* $Q = \frac{1}{3-K}$

Procedure:

1. Obtain the cut off frequency f_0 and the *Q-factor* for the component values shown in Fig. Verify that the circuit corresponds to a low pass Butter worth filter where the *Q-factor* = $\sqrt{2}$.

2. Fabricate the circuit on a breadboard. Apply 3V p-p sinusoidal signal from a function generator at V_1. Measure and plot the gain $(V_0 \mid V_1)$ at approximately $f_0/10, f_0/2, f_0, 2f_0, 10f_0$ etc. Ensure that V_1 remains Constant for all the frequencies. Due to the imperfect values of resistors and capacitors, the experimentally obtained cut off frequency will differ from the theoretical one. Find out the deviation.
3. Apply p-p square wave at 2kHz at the input and observe the output waveform on the CRO. Notice the overshoot at the output pulse edges.
4. Now change the R_1 value to 10kΩ. Repeat step3. Do you see any noticeable difference ? Now repeat step 2 for the modified circuit.

Report:

1. Derive the expression for transfer function.

2. Identify the type of the filter in the modified circuit. Comment on its Performance compared to Butter worth filter.

3. If you interchange R_1, R_2 with C_1, C_2 what type of filter characteristics would you get?