

ELE339, Electronics Laboratory

LAB 1 RC Active Filters

Pre-Lab

Objective:

Frequency selective filters are frequently used in communication systems to band limit signal and to separate and retrieve specific channels. While filters can be realized with passive components (R,L,C) exclusively, designer prefer RC active filters, which replace the comparatively expensive (and lossy) inductors with active circuitry based on op-amps.

About the op-amps

All circuits investigated in this lab will be realized using the LF356 JFET opamp operated with +/-10V supplies. To simplify the circuit analysis, we will assume an ideal amplifier, which possesses infinite gain (zero differential input voltage) and infinite input impedance (zero amplifier input currents).

Tasks:

1. Derive an expression for the voltage transfer function V_{out}/V_{in} of the circuit depicted in figure 1. Find the dc voltage gain and the 3dB corner frequency of the circuit if $R_1=1k\Omega$, $R_2=1.5k\Omega$ and $C_1=33nF$.
2. Find a symbolic expression for the voltage transfer function V_{out}/V_{in} of the circuit depicted in figure 2. This second-order transfer function will be of the form

$$T(s) = -k \frac{\omega_p^2}{s^2 + s\omega_p / Q_p + \omega_p^2}$$

where $s=j\omega$ denotes the complex (radian) frequency.

3. Determine the dc gain k , the corner frequency ω_p and the quality factor Q_p of this transfer function if $R_1=R_2=R_3=1.5k\Omega$, $C_1=100nF$ and $C_2=22nF$.
4. What filter function would you obtain if you were to interchange in Figs 1 and 2 each resistor with a capacitor and vice versa? A qualitative answer is sufficient (explain and provide an approximate sketch of the expected function)

Experimental

5. Realized the circuit depicted in figure 1 on your Protoboard and verify its functionality. To do so, apply a sinusoidal input with a swing of 2V and record the magnitude and phase response between 100Hz and 100 kHz using 10 logarithmically spaced steps per decade.
6. Realize circuit 2 on your Protoboard and verify its functionality. To do so, repeat the same procedure you applied in task 4.
7. Show your measurements in a Bode plot format. How close do the measured data confirm your predictions from task 3?

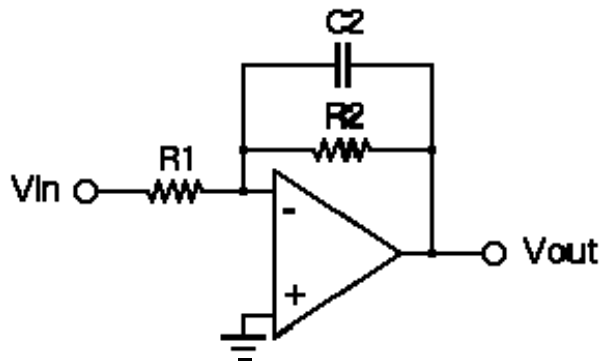


Figure 1: Simple first-order lowpass with adjustable gain.

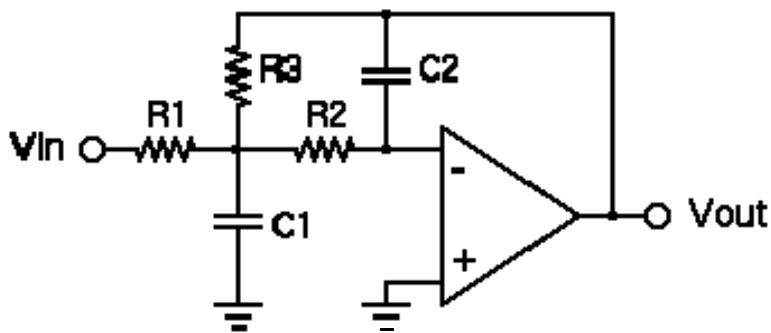


Figure2: Second-order RC active lowpass filter.