

EE230- Analog lab (Labwork-7)

Spring Semester: Year 2021-22

March 11, 2022

Instructions:

- Write your netlists and show the results of each question to the evaluating TA during the lab session on March 10, 2022.
- No Additional time will be given.
- You can refer: NGSPICE tutorial, model files uploaded on the course moodle / MS Team-channel and your written netlists of previous experiments / homeworks.

1. **Special Opamp Linear Circuits - Active Filters** In the Homework-6, we have considered single pole active Low pass and High pass filters. In the lab-exercise, we will be considering the following circuits

i) Sallen-Key (2-pole) Active Low-pass Filter, ii) Sallen-Key (2-pole) Active High-pass Filter, iii) Active Band-Pass Filter

(a) Sallen-Key (2-pole) Active Low-pass Filter

- i. Circuit values: $R_A = R_B = 4.7k\Omega$, $C_A = C_B = 0.1\mu F$, $R_1 = 1.8k\Omega$, $R_2 = 3.3k\Omega$
- ii. The cut-off frequency of the filter is given by,
 $f_c = \frac{1}{2\pi RC}$, where $R = R_A = R_B$, $C = C_A = C_B$.

Note that this filter is a two-pole filter and hence it has a much sharper roll-off of -40 dB/decade beyond the cut-off frequency. R_1 and R_2 values are chosen such that $R_1 = 0.586R_2$. (Refer to the following pages of the reference material uploaded on MS Teams and moodle: Damping Factor Sec 15.2, page 770, Flyod 9e).

- iii. Simulate the filter response of the circuit in Fig.[1]. Plot the filter response and compare the theoretical results (cut-off frequency and roll-off) with the ideal case.

(b) Sallen-Key (2-pole) Active High-pass Filter

- i. Circuit values: $R_A = R_B = 4.7k\Omega$, $C_A = C_B = 0.1\mu F$, $R_1 = 1.8k\Omega$, $R_2 = 3.3k\Omega$

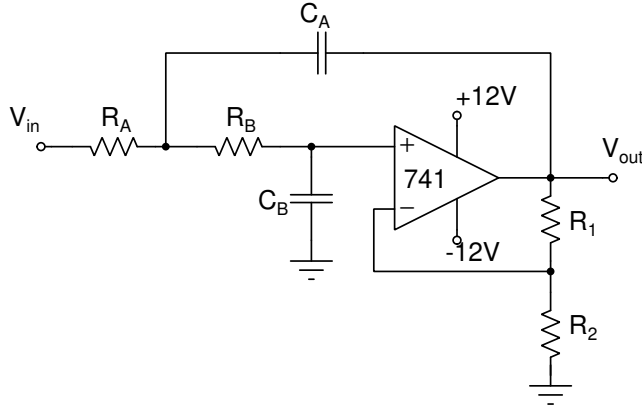


Figure 1: Sallen-Key (2-pole) active low-pass filter

- ii. The cut-off frequency of the filter is given by,
 $f_c = \frac{1}{2\pi RC}$, where $R = R_A = R_B, C = C_A = C_B$.

Note that this filter is a two-pole filter and hence it has a much sharper roll-off of -40 dB/decade beyond the cut-off frequency. R_1 and R_2 values are chosen such that $R_1 = 0.586R_2$. (Refer to the following pages of the reference material uploaded on MS Teams and moodle: Damping Factor Sec 15.2, page 770, Flyod 9e).

- iii. Simulate the filter response of the circuit in Fig.[2]. Plot the filter response and compare the theoretical results (cut-off frequency and roll-off) with the ideal case.

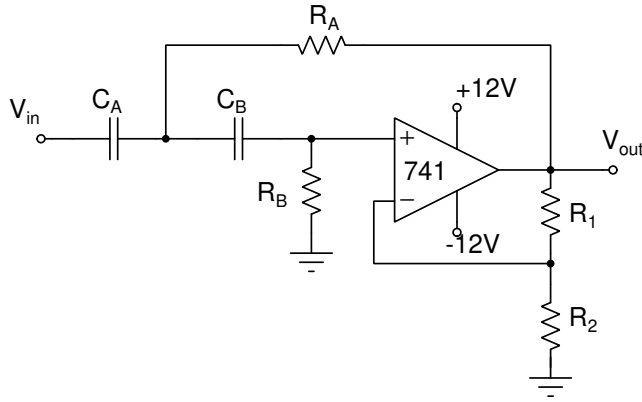


Figure 2: Sallen-Key (2-pole) active high-pass filter

(c) Multiple-feedback Active Band-Pass Filter

- i. Circuit Values: $R_1 = 68k\Omega, R_2 = 180k\Omega, R_3 = 2.7k\Omega, C_1 = C_2 = 0.01\mu F$
 ii. The center frequency of the filter is given by,

- $f_0 = \frac{1}{2\pi C} \sqrt{\frac{R_1 + R_3}{R_1 R_2 R_3}}$, where $C = C_1 = C_2$ and Bandwidth of the circuit is given by, $BW = \frac{f_0}{Q}$, where $Q = \pi f_0 C R_2$
- iii. Simulate the filter response of the circuit in Fig.[3]. Plot the filter response, find the center frequency and Bandwidth and compare the theoretical and ideal results (bandwidth and center frequency).

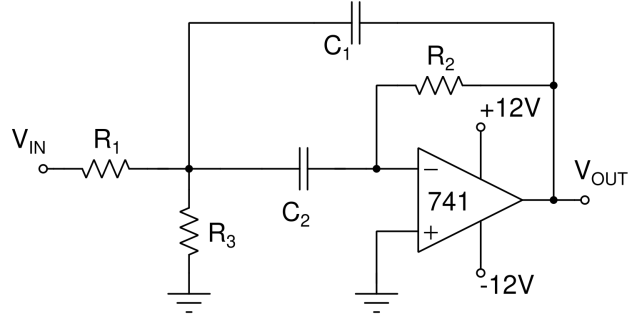


Figure 3: Multiple Feedback Active BPF