EE230- Analog lab (Labwork-7)
Spring Semester: Year 2021-22

March 10, 2022

Instructions:

- Perform the experiment 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.

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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: $R_A = R_B = 4.7k\Omega, C_A = C_A = 0.1\mu F, R_1 = 1.8k\Omega, R_2 = 3.3k\Omega$

      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. Experimentally find 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: $R_A = R_B = 4.7k\Omega, C_A = C_A = 0.1\mu F, R_1 = 1.8k\Omega, R_2 = 3.3k\Omega$

      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

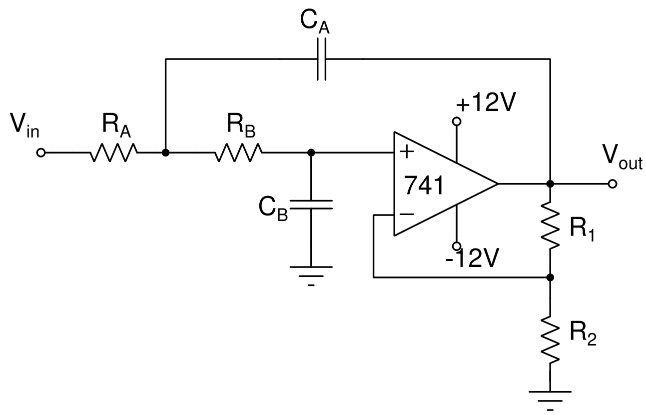

Figure 1: Sallen-Key (2-pole) active low-pass filter

$R_1 = 0.586 R_2$. (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. Experimentally find 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.

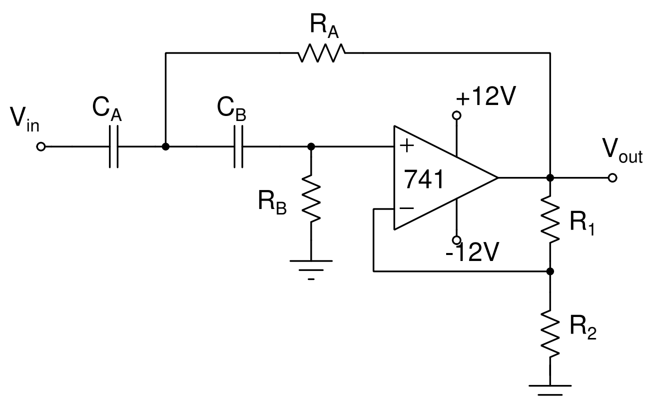

Figure 2: Sallen-Key (2-pole) active high-pass filter

(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 cut-off frequency of the filter is given by,
$f_c = \frac{1}{2\pi C}\sqrt{\frac{R_1+R_3}{R_1 R_2 R_3}}$, where $C = C_1 = C_2$ and Bandwidth is given by, BW $= \frac{f_0}{Q}$, where $Q = \pi \mathrm{f}_0 C R_2$

iii. Experimentally find 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).

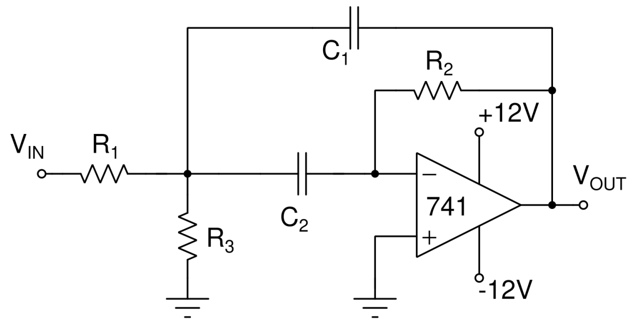

Figure 3: Multiple Feedback Active BPF