EE230- Analog lab (Homework-6)
Spring Semester: Year 2021-22

March 6, 2022

Instructions:

- Show your netlists and simulation results of each question to the evaluating TA.
- **Deadline: March 10, 2:00 pm.**
- **You can refer:** NGSPICE tutorial, model files uploaded on the course moodle / MS Teams channel and your written netlists of previous experiments.

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1. **Special Opamp Linear Circuits - Active Filters**

   Active filters are much more versatile than passive filters. At a basic level they may be thought of as a combination of RC circuits along with Opamps or other active elements, with the ability to provide the desired voltage gain to the filtered signal. In addition to the above feature, active filters provide much more power to the designer with the ability to the design filters with larger Q, sharper cut off etc.

   Based on the shape of the filter response curve the filters (both passive and active) may be called Butterworth, Chebyshev, or Bessel filters. Each one of these filters has an advantage in certain applications. Butterworth filters are the ones most commonly used. They have a maximally flat response.

   In our experiment we shall consider the following basic active filter circuits, so as to appreciate their basic features. i) Single-pole Active Low-pass Filter (Butterworth), ii) Single-pole Active High-pass Filter (Butterworth), iii) Sallen-Key (2-pole) Active Low-pass Filter, and iv) iii) Sallen-Key (2-pole) Active High-pass Filter.

   (a) Single-pole Active Low-pass Filter

      i. Circuit values: $R_A = 4.7k\Omega, C_A = 0.1\mu F, R_1 = 9.1k\Omega, R_2 = 1k\Omega$

      ii. The circuit diagram of a single-pole active low-pass Butterworth filter is shown in Fig.[1]. It is nothing but a cascade of a single-pole RC low-pass filter and a non-inverting amplifier. The cut-off frequency of the filter is given by, $f_c = \frac{1}{2\pi RC}$. In the circuit shown $R = R_A, C = C_A$.

      iii. Simulate the filter response of the circuit in Fig.[1]. Plot the filter response and compare the theoretical results with the simulation results.

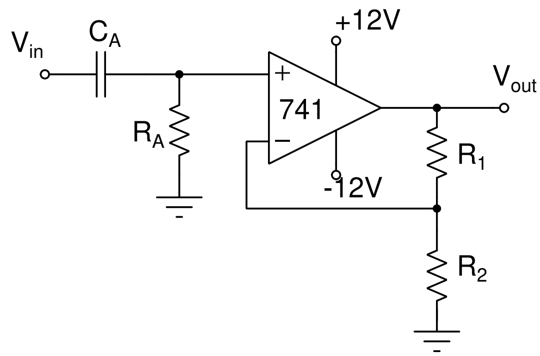

Figure 1: Single-pole active low-pass filter

(b) Single-pole Active High-pass Filter

i. Circuit values: $R_A = 4.7k\Omega, C_A = 0.1\mu F, R_1 = 9.1k\Omega, R_2 = 1k\Omega$

ii. The circuit diagram of a single-pole active high-pass Butterworth filter is shown in Fig.[2]. Similar to the circuit in Fig.[1], the circuit in Fig.[2] is a cascade of a single-pole RC high-pass filter and a non-inverting amplifier. The cut-off frequency of the filter is given by, $f_c = \frac{1}{2\pi RC}$. In the circuit shown $R = R_A, C = C_A$.

iii. Simulate the filter response of the circuit in Fig.[2]. Plot the filter response and compare the theoretical results with the simulation results.

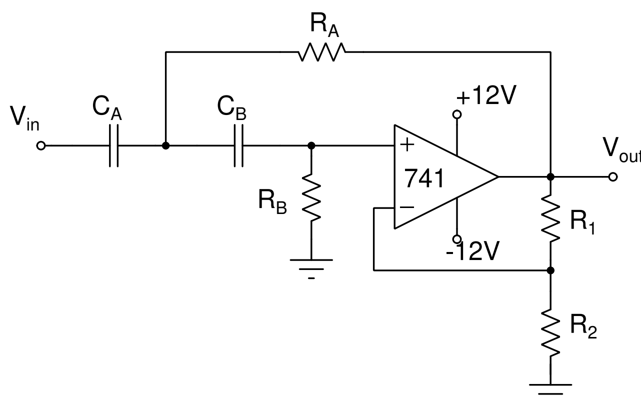

Figure 2: Single-pole active high-pass filter