February 16, 2024

1 Transfer Function

Low Pass:

$$\frac{v_{in} - x}{R_1} + \frac{v_0 - x}{R_2} + (v_0 - x)C_2 s = 0$$

$$\frac{v_0 - x}{R_2} + v_0 C_1 s = 0$$

Solving, we have For the Low Pass filter, the transfer function $H(s)$ is given by:

$$H(s) = \frac{1}{c_1 c_2 R_1 R_2 s^2 + s c_1 (R_1 + R_2) + 1}$$

This equation describes the relationship between the input (v_{in}) and output (v_0) signals in the Low Pass filter circuit.

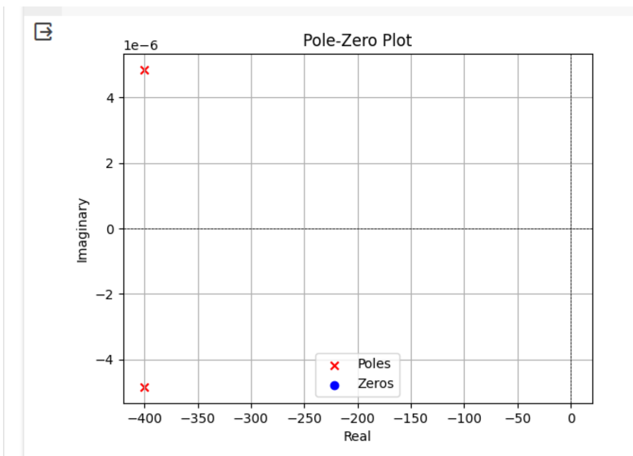

Figure 1: Pole Zero Plot for Low Pass Filter

Band Pass:

$$v_{in} - iR_1 - \frac{i}{C_1 s} - \frac{i}{C_2 s(1 + C_2 s)} = V_0$$

$$i = \frac{v_{in}}{R_1 + \frac{1}{c_1 s}}$$

on solving we get

$$H(s) = -\frac{c_1}{c_2} \cdot \frac{1}{(R_1 C_1 s + 1)(R_2 C_2 s + 1)}$$

This equation describes the relationship between the input (v_{in}) and output (V_0) signals in the High Pass filter circuit.

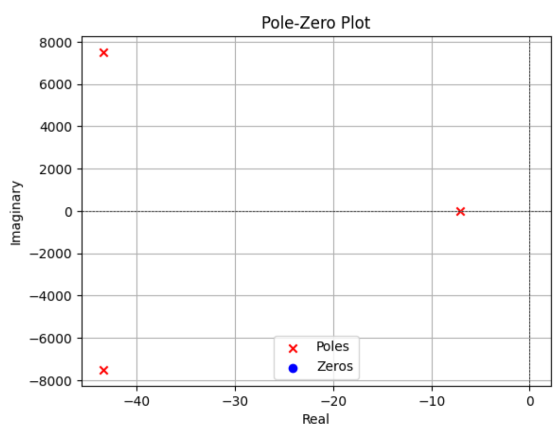

Figure 2: Pole Zero Plot for High Pass Filter

As seen in both the plots, the poles have negative real value, thus the design is stable.

For the Python code generating these plots, refer to `https://colab.research.google.com/drive/1koj8sK5V5i7SiOVdr0mSccGSmV1wG-v0?authuser=1#scrollTo=-b5ql538-t14`.