Daniel Ayala

Problem set

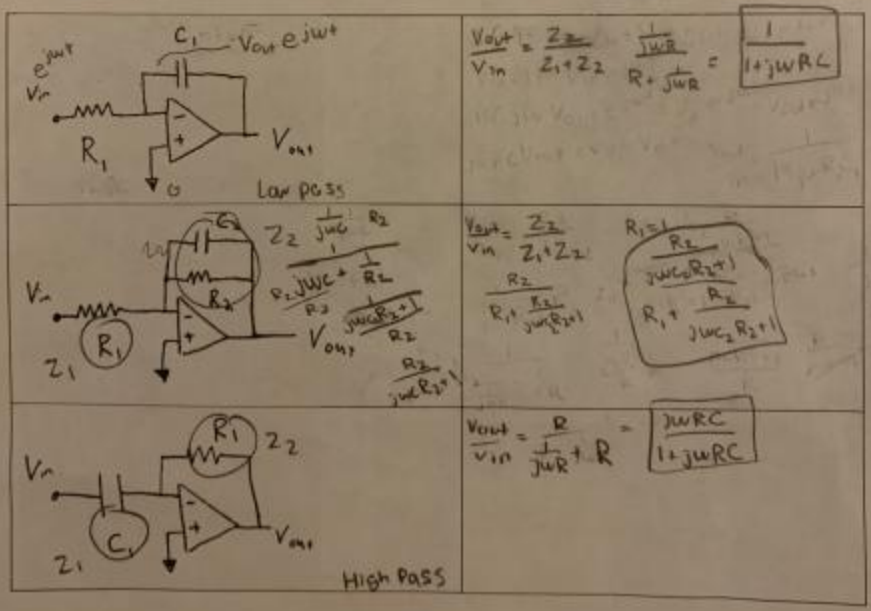
Analysis of filters with complex impedance

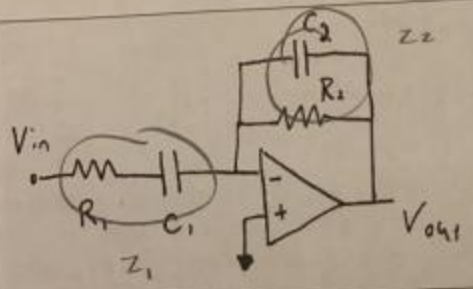
For each of the circuits in the table, figure out the complex number that represents the ratio of the output voltage divided by the input voltage. Write your final result in the tables. For each circuit in the table, create a plot of the magnitude of this complex number as a function of frequency. Put both the magnitude and frequency on a logscale. For each circuit use:

- R1 = 1 kΩ C1 = 1 µF
- R2 = 10 kΩ C2 = 0.1 µF

Remember, the impedance of a resistor and capacitor are

- $Z_R = R$
- $Z_C = \frac{1}{j\omega C}$



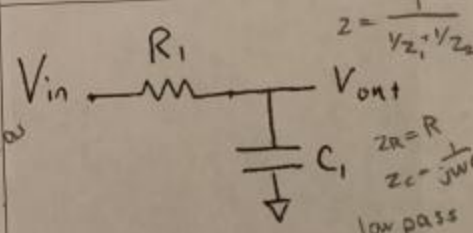


$Z_2 = \frac{R_2}{j\omega C_2 R_2 + 1}$

$Z_1 = R_1 + \frac{1}{j\omega C_1}$

$\frac{Z_2}{Z_1 + Z_2}$

$$\frac{\frac{R_2}{j\omega C_2 R_2 + 1}}{R_1 + \frac{1}{j\omega C_1} + \frac{R_2}{j\omega C_2 R_2 + 1}}$$



$Z = \frac{1}{1/Z_1 + 1/Z_2}$

$Z_R = R$

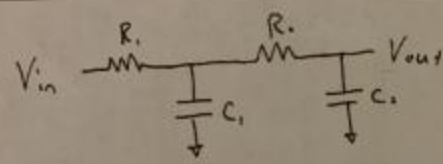
$Z_C = \frac{1}{j\omega C}$

low pass

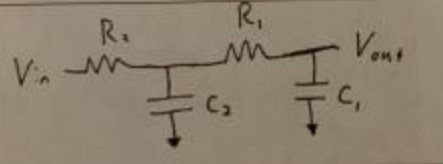
$V_{out} = V_{in} \frac{R_1}{R_1 + R_1}$ Z_R $\frac{1}{R j\omega C_1 + 1}$

$V_{out} = V_{in} \frac{Z_2}{Z_1 + Z_2}$ $\frac{\frac{1}{j\omega C_1}}{R + \frac{1}{j\omega C_1}}$

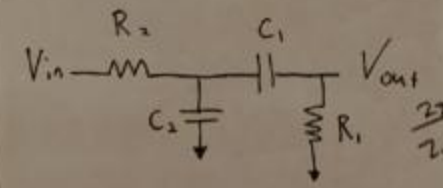
$\frac{V_{out}}{V_{in}} = \frac{Z_2}{Z_1 + Z_2}$



$$Z_R = \frac{1}{R_1 j\omega C_1 + 1} + \frac{1}{R_2 j\omega C_2 + 1}$$



$$Z = \frac{1}{R_2 j\omega C_2 + 1} + \frac{1}{R_1 j\omega C_1 + 1}$$

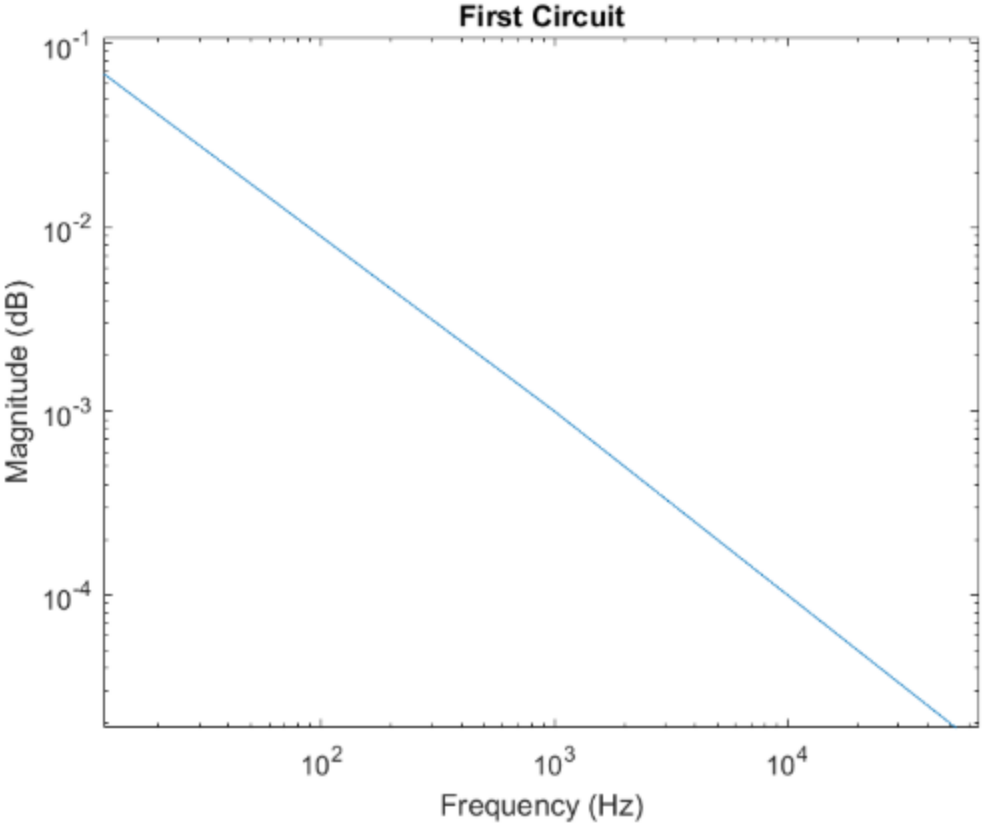


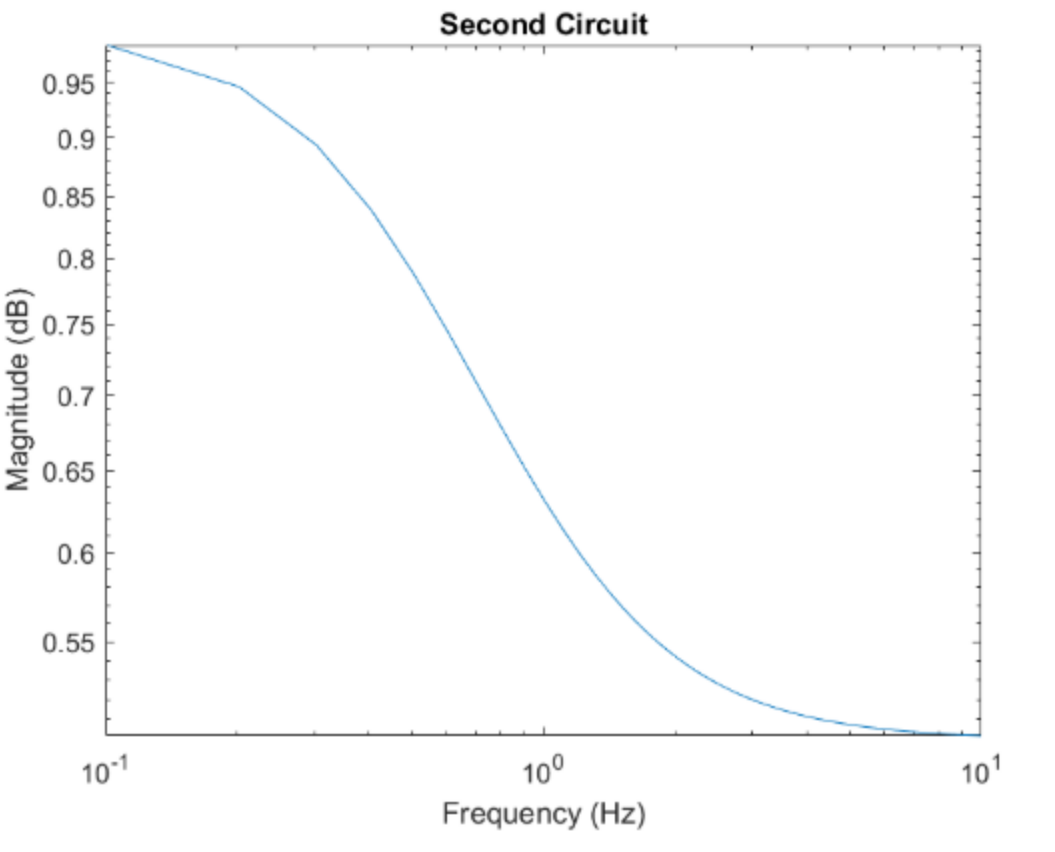
$$Z_R = \frac{1}{R_2 j\omega C_2 + 1} + \frac{j\omega C_1}{1 + j\omega C_1 R_1}$$

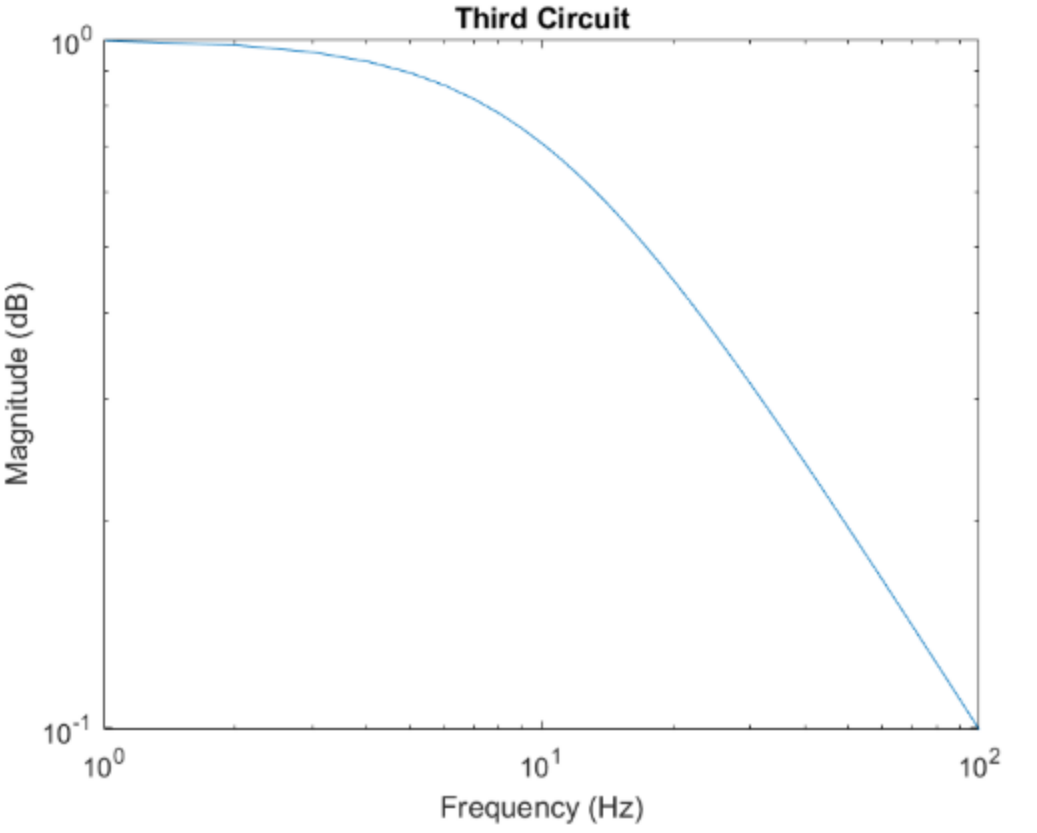
$\frac{Z_2}{Z_1 + Z_2}$

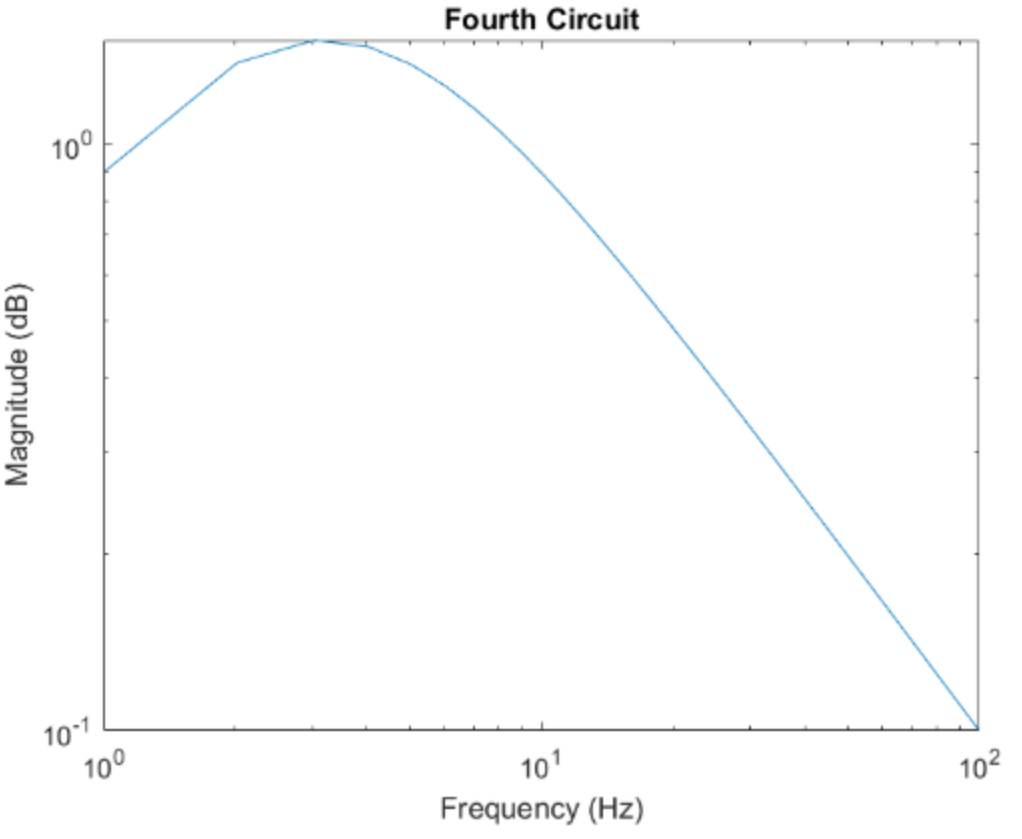
C_1 $\frac{R_1}{\frac{1}{j\omega C_1} + R_1}$

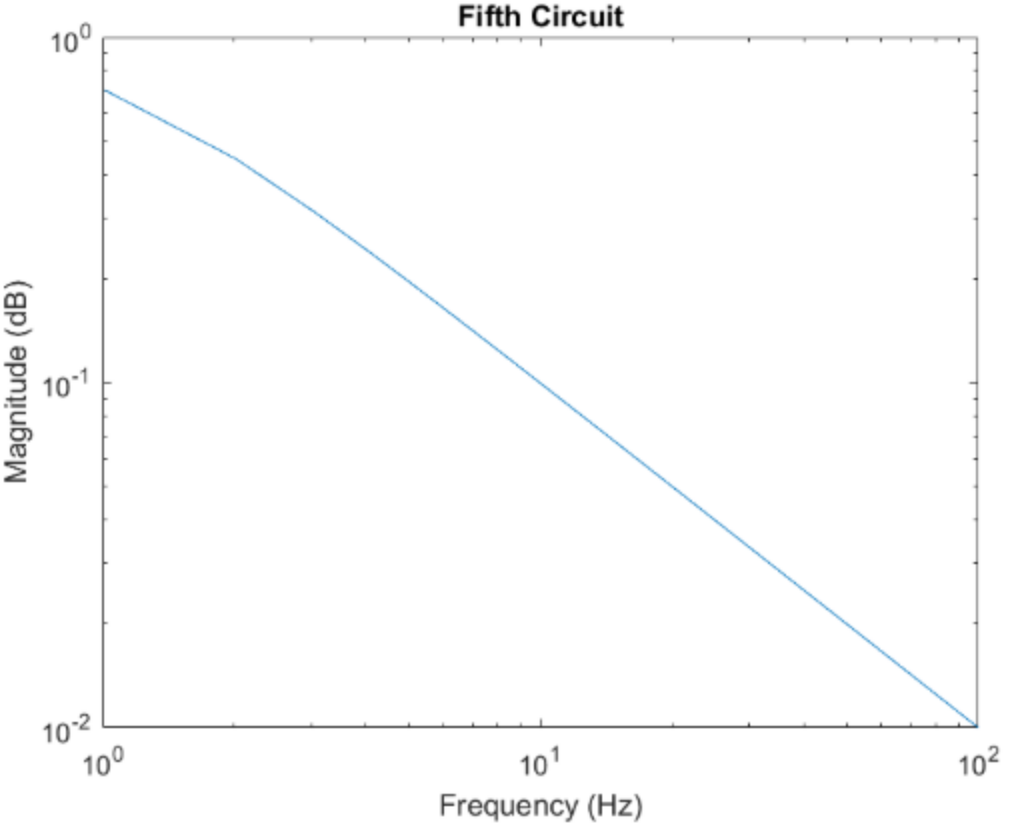
R_1

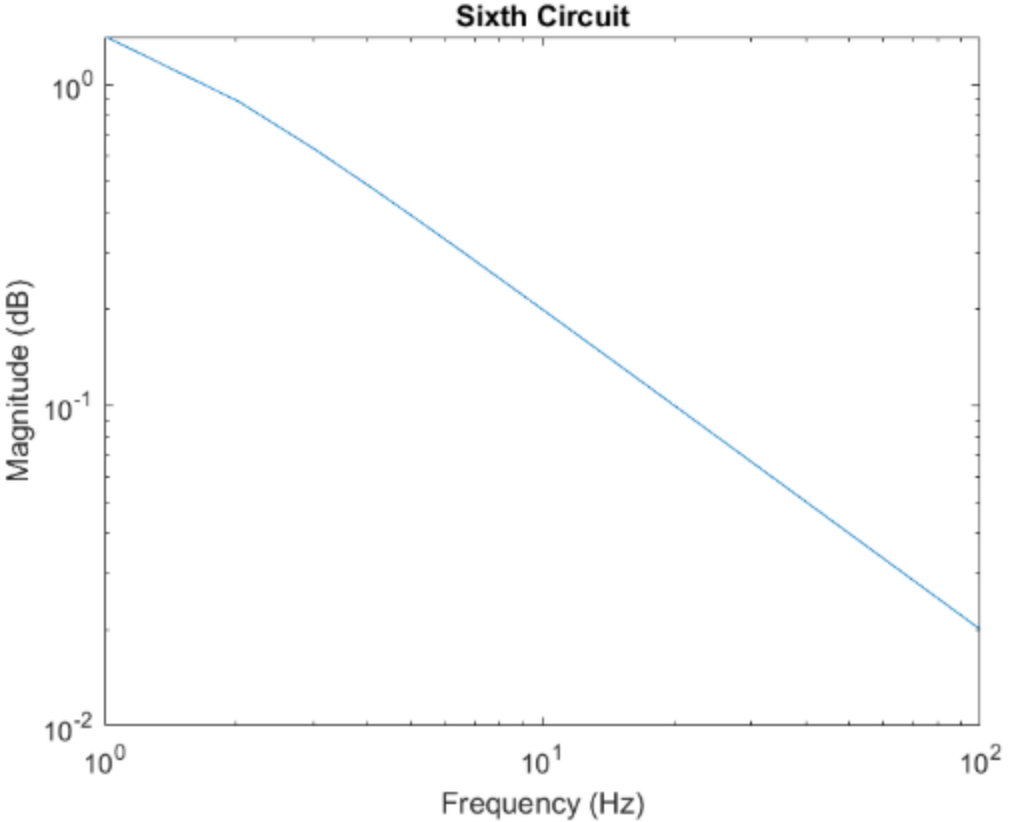

First Circuit
Magnitude (dB)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{2}
10^{3}
10^{4}
Frequency (Hz)

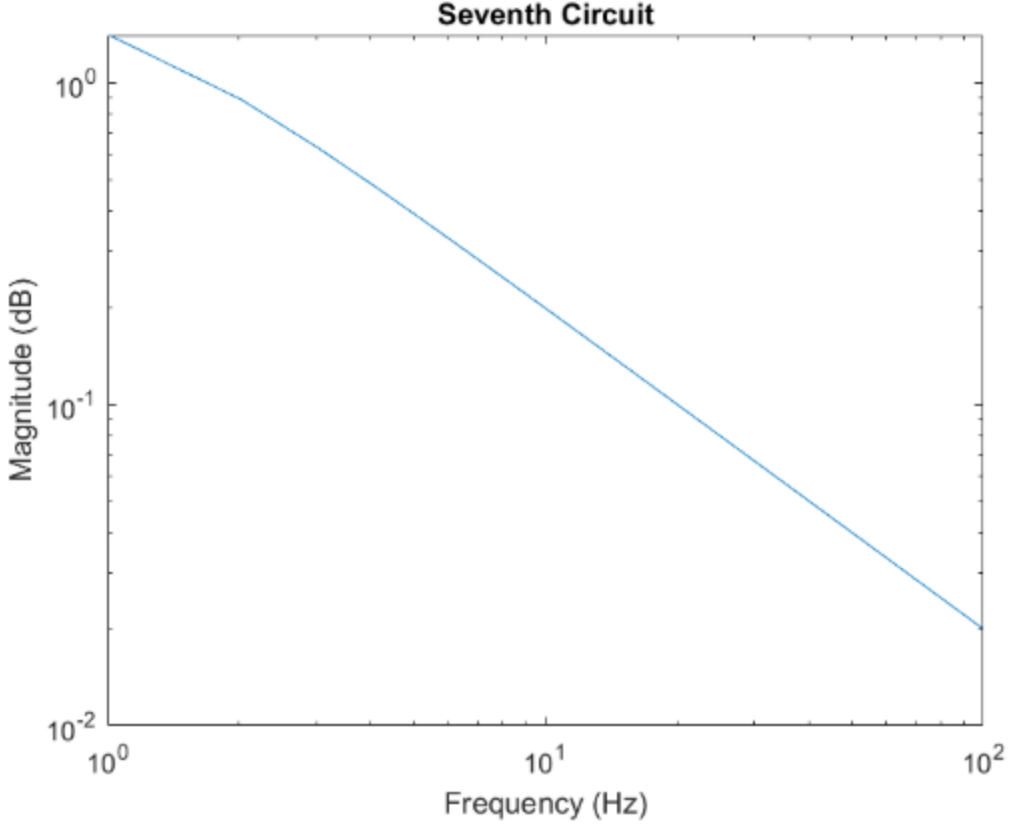

Second Circuit
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
Magnitude (dB)
10^-1
10^0
10^1
Frequency (Hz)

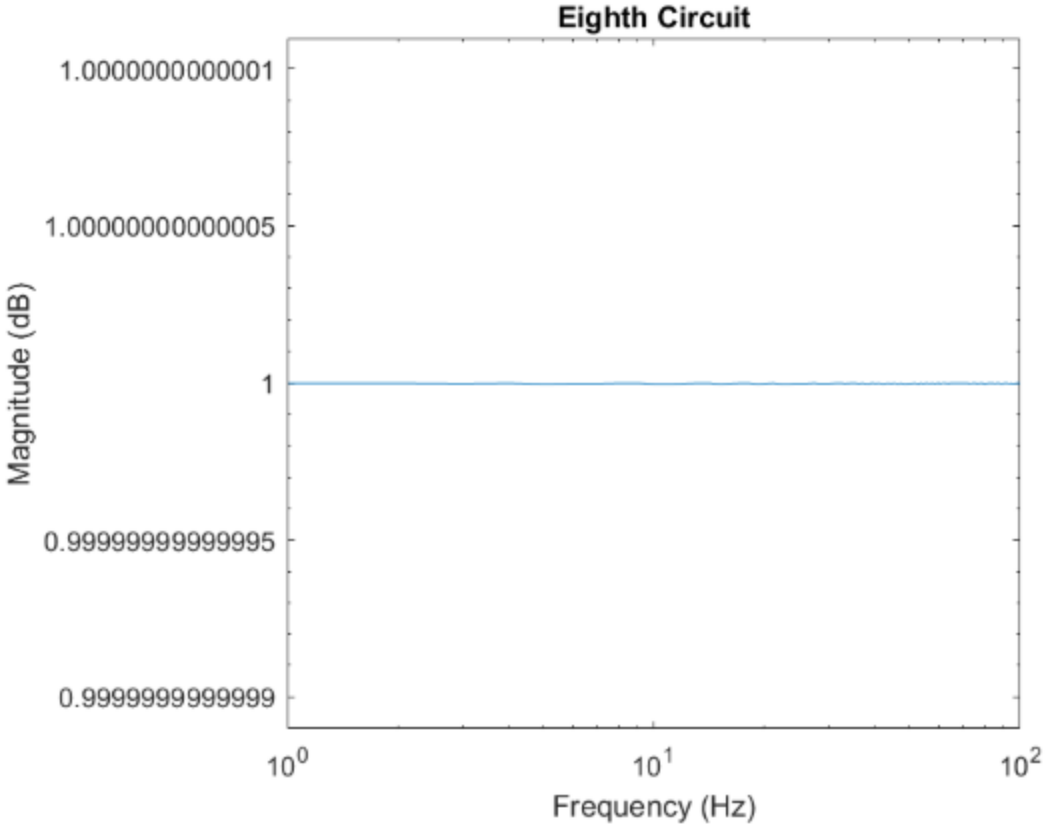

Third Circuit
10^0
10^{-1}
Magnitude (dB)
10^0
10^1
10^2
Frequency (Hz)


Fourth Circuit
Magnitude (dB)
10^0
10^{-1}
10^0
10^1
10^2
Frequency (Hz)


Fifth Circuit
10^0
10^{-1}
10^{-2}
Magnitude (dB)
10^0
10^1
10^2
Frequency (Hz)


Sixth Circuit
Magnitude (dB)
10^{0}
10^{-1}
10^{-2}
10^{0}
10^{1}
10^{2}
Frequency (Hz)


Seventh Circuit
Magnitude (dB)
10^{0}
10^{-1}
10^{-2}
10^{0}
10^{1}
10^{2}
Frequency (Hz)


Eighth Circuit
1.0000000000001
1.00000000000005
1
0.99999999999995
0.9999999999999
Magnitude (dB)
10^0
10^1
10^2
Frequency (Hz)