BIRZEIT UNIVERSITY

Department of Electrical & Computer Engineering
ENEE2103 - Circuits and Electronics Laboratory

Experiment #5
Filters

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Abstract:
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1 Theory

Filters in circuits allow ciruin frequincies to pass through while blocking undesired frequencies. Filters are classified into two types: passive and active filters. Passive filters are made of passive components such as resistors, capacitors, and inductors. Active filters are made of active components such as transistors and op-amps. A filter order is the number of reactive components in the filter. Furthermore, filters have four basic types: low pass, high pass, band pass, and band stop.

1.1 Passive Filters

1.1.1 Low Pass Filter

As the name suggests, this type of filters allow low frequencies to pass through while blocking high frequencies.

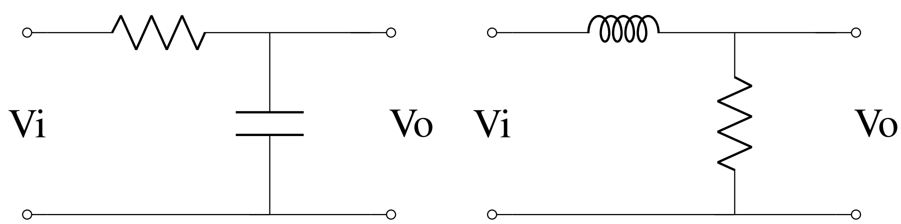

Figure 1: 1^{st} Order Passive Low-Pass filters

$$\begin{aligned} V_o &= \frac{X_c}{X_c + X_r} \times V_i & \qquad V_o &= \frac{X_r}{X_r + X_l} \times V_i \\ X_c &= \frac{1}{j\omega c} & X_l &= j\omega l \end{aligned} \tag{1}$$

The freqeuncy is inversely proportinal to the impedance X_c, and X_c is directly proportinal to V_o, and by the same logic the frequency is directly proportinal to X_l, and X_l is inversely proportinal to V_o, which indicates that higher freqeuncies generate low voltage (reject), and low freqeuncies generate high voltage (pass).

The cut-off frequency is the frequency at which point of inversion occurs, which indeicates what a high and low frequeinces are,and its given by:

$$f_c = \frac{1}{2\pi RC} \qquad or \qquad f_c = \frac{R}{2\pi L} \tag{2}$$

1.1.2 High Pass Filter

This type of filter is a complement of the low-pass filter, since it rejects low frequeinces and passes high ones.

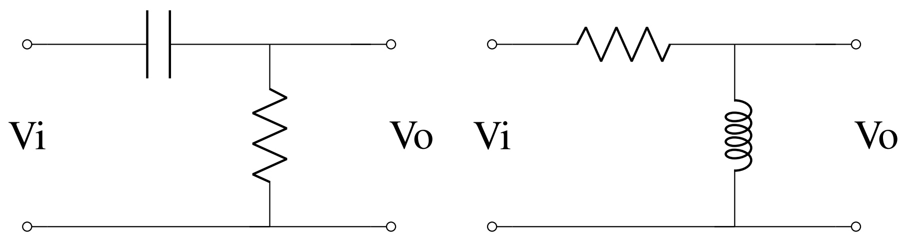

Figure 2: 1^{st} Order Passive High-Pass filters

$$V_o = \frac{X_r}{X_c + X_r} \times V_i \qquad V_o = \frac{X_l}{X_r + X_l} \times V_i$$
$$X_c = \frac{1}{j\omega c} \qquad X_l = j\omega l \tag{3}$$

According to the above equations, the frequency is inversely proportinal to the impedance X_c, and X_c is inversely proportinal to V_o, and by the same logic the frequency is directly proportinal to X_l, and X_l is directly proportinal to V_o, which indicates that higher freqeuncies generate high voltage (pass), and low freqeuncies generate low voltage (reject).

The cut-off frequency is the frequency at which point of inversion occurs, which indeicates what a high and low frequeinces are,and its given by:

$$f_c = \frac{1}{2\pi RC} \qquad or \qquad f_c = \frac{R}{2\pi L} \tag{4}$$

1.1.3 Band Pass Filter

1.1.4 Band Stop Filter

1.2 Active Filters

2 Procedure and Data Analysis

3 Discussion

4 Conclusion

5 References

6 Appendix