Dr Satvir Singh

LINEAR INTEGRATED CIRCUITS

3-09

Band Pass, Band Stop & All Pass Filters

Outline

1. Butterworth First Order High Pass Filter
2. Butterworth Second Order High Pass Filter

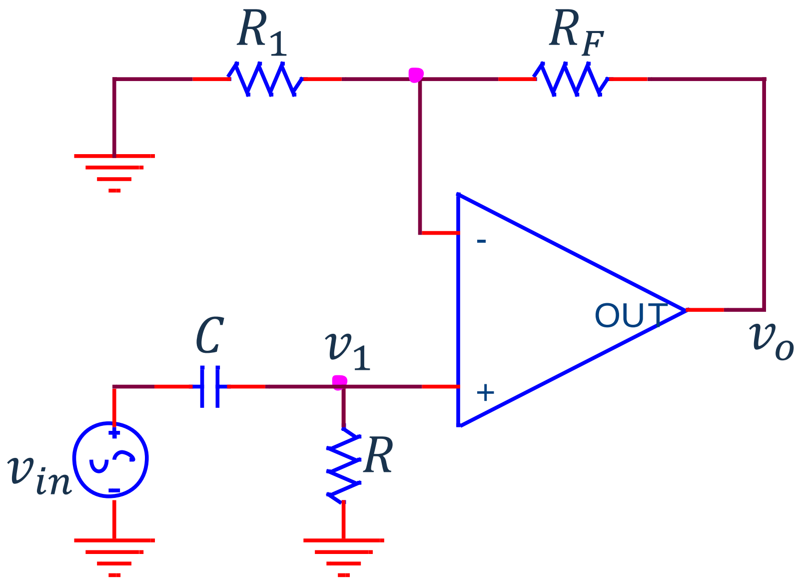
First Order Butterworth HPF

The output of non-inverting amplifier is

$$v_o = \left(1 + \frac{R_F}{R_1}\right) v_1$$

Where v_1 voltage is given as

$$v_1 = \frac{R}{R + \frac{1}{j2\pi f C}} v_{in} = \frac{j2\pi f CR}{1 + j2\pi f CR} v_{in}$$



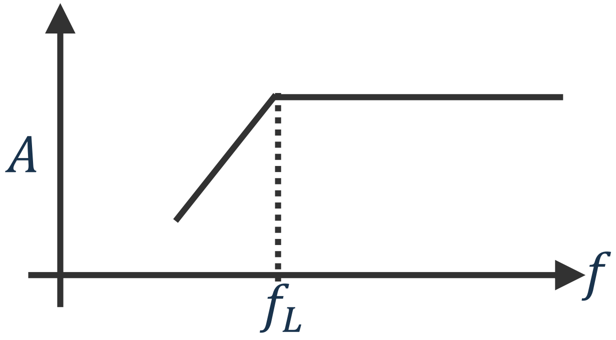
Output of the non-inverting amplifier

$$v_o = \left(1 + \frac{R_F}{R_1}\right) \frac{j2\pi f RC}{1 + j2\pi f RC} v_{in}$$

$$\frac{v_o}{v_{in}} = A_F \frac{j2\pi f RC}{1 + j2\pi f RC} = A_F \frac{j(f/f_L)}{1 + j(f/f_L)}$$

Here, $f_L = \frac{1}{2\pi RC}$ low cut-off frequency. Magnitude can be determined as

$$\left|\frac{v_o}{v_{in}}\right| = \frac{A_F(f/f_L)}{\sqrt{1 + (f/f_L)^2}}$$



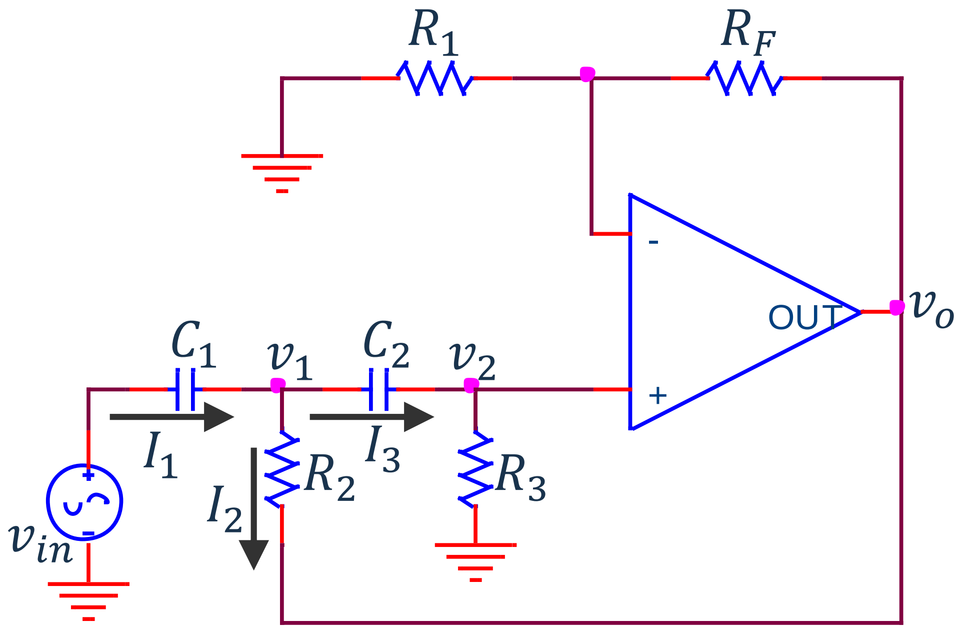
Second Order Butterworth LPF

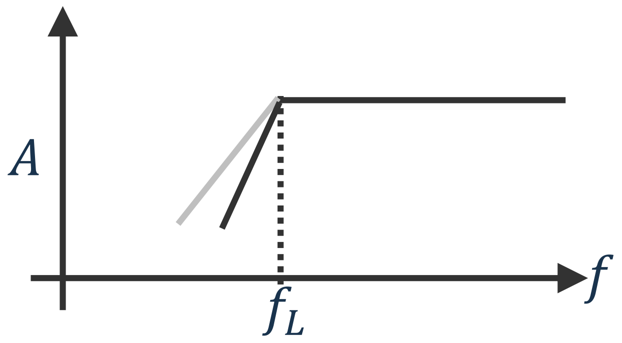
As we determined the cut-off frequency in Second Order Butterworth LPF, we can determine cut-off frequency of Second Order Butterworth HPF also.

$$f_L = \frac{1}{2\pi\sqrt{R_2 R_3 C_2 C_3}}$$

For simplicity, assume $R_2 = R_3 = R$ and $C_2 = C_3 = C$

$$f_L = \frac{1}{2\pi RC}$$





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Thank You