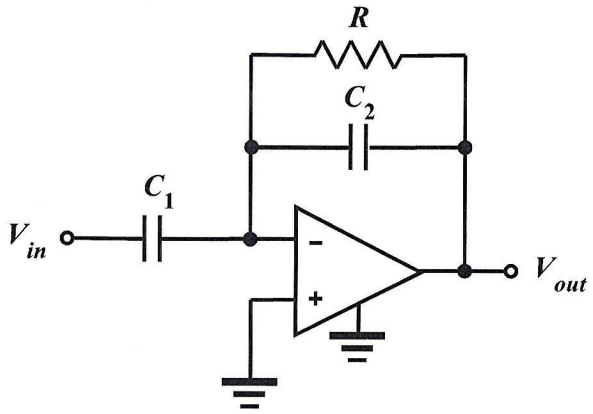
EE 3340

Homework Problem #025

a. For the active filter circuit shown below, determine an expression for the voltage transfer function in terms of R, C_1 and C_2.



$$\frac{V_{in}}{\left(\frac{1}{j\omega C_1}\right)} + \frac{V_{out}}{R} + \frac{V_{out}}{\left(\frac{1}{j\omega C_2}\right)} = 0 \Rightarrow j\omega C_1 V_{in} = -\left(\frac{1}{R} + j\omega C_2\right) V_{out}$$

$$\therefore \quad \frac{V_{out}}{V_{in}} = \frac{j\omega C_1}{\frac{1}{R} + j\omega C_2}$$

b. Characterize the circuit as LP or HP, and justify your decision by determining values for the low-frequency gain, the high-frequency gain, and the cutoff frequency.

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{\omega C_1}{\sqrt{\left(\frac{1}{R}\right)^2 + (\omega C_2)^2}}$$

$$\lim_{\omega \to 0} \left|\frac{V_{out}}{V_{in}}\right| = 0 \quad \leftarrow \text{low-frequency gain}$$

$$\lim_{\omega \to \infty} \left|\frac{V_{out}}{V_{in}}\right| = \frac{C_1}{C_2} \quad \leftarrow \text{high-frequency gain}$$

$\therefore$ This is a High Pass (HP) filter.

At the cutoff frequency:

$$\frac{\omega_c C_1}{\sqrt{\left(\frac{1}{R}\right)^2 + (\omega_c C_2)^2}} = \frac{1}{\sqrt{2}} \frac{C_1}{C_2} \Rightarrow \frac{1}{R} = \omega_c C_2 \Rightarrow \omega_c = \frac{1}{RC_2}$$