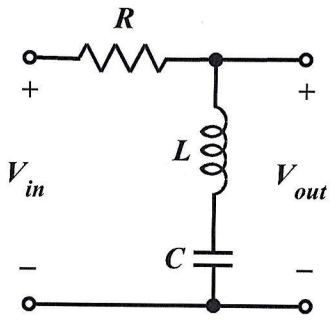
EE 3340

Homework Problem #023

A passive *RLC* filter circuit is given below.



a. Determine an expression for the voltage transfer function, $\mathbf{V}_{out}/\mathbf{V}_{in}$. Also, determine expressions for the magnitude and the phase angle of that transfer function.

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

$$\frac{V_{out}}{V_{in}} = \frac{\frac{1}{R}}{\frac{1}{R} + \frac{1}{j\omega L + \frac{1}{j\omega C}}} = \frac{1}{1 + \frac{j\omega RC}{1-\omega^2 LC}} = \frac{1-\omega^2 LC}{(1-\omega^2 LC) + j\omega RC}$$

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{|1-\omega^2 LC|}{\sqrt{(1-\omega^2 LC)^2 + (\omega RC)^2}}$$

$$\angle\frac{V_{out}}{V_{in}} = -\tan^{-1}\left(\frac{\omega RC}{1-\omega^2 LC}\right)$$

a. Classify the filter as LP, HP, BP or BS, and explain your reasoning.

$$\lim_{\omega \to 0}\left|\frac{V_{out}}{V_{in}}\right| = \frac{1}{1} = 1$$

$$\lim_{\omega \to \infty}\left|\frac{V_{out}}{V_{in}}\right| = \frac{\omega^2 LC}{\omega^2 LC} = 1$$

If $\omega = \frac{1}{\sqrt{LC}}$, then $\left|\frac{V_{out}}{V_{in}}\right| = 0$

This is a Band Stop (BS) filter characteristic