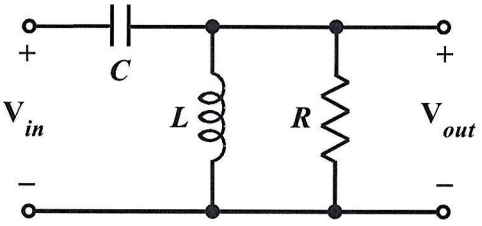
EE 3340

Homework Problem #022

The component values in the passive filter circuit shown below are: $C = 10\,\mu\text{F}$, $L = 1\text{H}$, and $R = 10\text{k}\Omega$.



a. Derive 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.

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

$$= \frac{-0.1\omega^2}{10^4(1 - 10^{-5}\omega^2) + j\omega}$$

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{0.1\omega^2}{\sqrt{10^8(1 - 10^{-5}\omega^2)^2 + \omega^2}}$$

$$\angle\frac{V_{out}}{V_{in}} = 180^\circ - \tan^{-1}\frac{\omega}{10^4(1 - 10^{-5}\omega^2)}$$

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

$$\lim_{\omega \to 0}\left|\frac{V_{out}}{V_{in}}\right| = \frac{0}{10^4} = 0$$

$$\lim_{\omega \to \infty}\left|\frac{V_{out}}{V_{in}}\right| = \lim_{\omega \to \infty}\frac{0.1\omega^2}{0.1\omega^2} = 1$$

This is a High Pass (HP) filter characteristic.