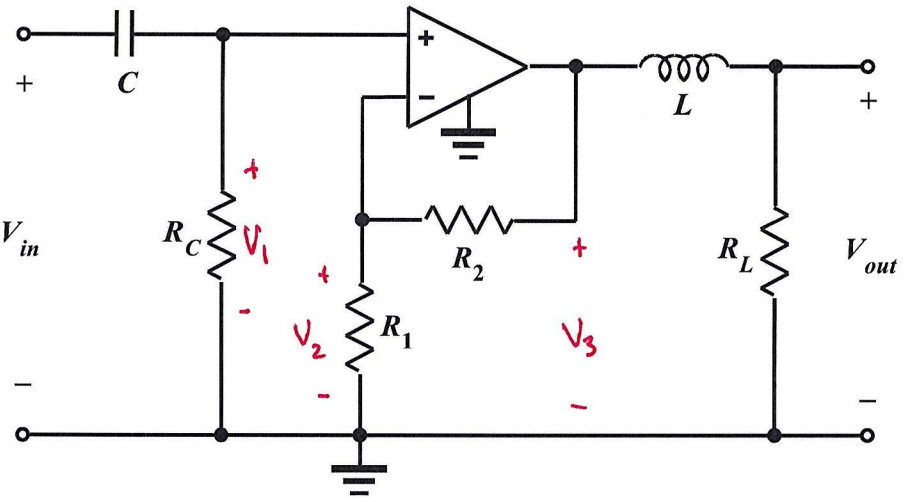
EE 3340

Homework Problem #026

a. For the active filter circuit shown below, determine an expression for the voltage transfer function in terms of C, R_C, R_1, R_2, L and R_L.



$$V_{out} = \frac{R_L}{R_L + j\omega L} V_3, \quad V_3 = \left(1 + \frac{R_2}{R_1}\right) V_2, \quad V_2 = V_1, \quad V_1 = \frac{R_C}{R_C + \frac{1}{j\omega C}} V_{in}$$

$$\therefore \quad \frac{V_{out}}{V_{in}} = \left(\frac{R_L}{R_L + j\omega L}\right)\left(1 + \frac{R_2}{R_1}\right)\left(\frac{R_C}{R_C + \frac{1}{j\omega C}}\right)$$

b. Characterize the circuit as BP or BS, and explain your decision.

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{R_L\left(1 + \frac{R_2}{R_1}\right)(R_C)}{\sqrt{\left[R_L^2 + (\omega L)^2\right]\left[R_C^2 + \left(\frac{1}{\omega C}\right)^2\right]}}$$

$\lim_{\omega \to \infty} \left|\frac{V_{out}}{V_{in}}\right| = 0$, $\lim_{\omega \to 0} \left|\frac{V_{out}}{V_{in}}\right| = 0$, $\left|\frac{V_{out}}{V_{in}}\right|$ can never be < 0

$\therefore$ This is a Band Pass (BP) filter.

c. Given $C = 5$ nF, $R_C = 100$ kΩ, $R_1 = 10$ kΩ, $R_2 = 90$ kΩ, $L = 1.1$ H and $R_L = 200$ kΩ, use LTspice to verify your claim.

See the attachment.

d. Use your LTspice plot to estimate the cutoff frequencies for this filter.

The cutoff frequencies are ≈ 300 Hz and ≈ 20k Hz

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* Q:\EE 3340\homework problems\26.cir
Vin in  0   AC  1   0
C   in  1   5n
RC  1   0   100k
R1  2   0   10k
R2  2   3   90k
E   3   0   2   1   1T
L   3   out 1.1
RL  out 0   200k
.AC DEC 10  1m  1g
.end
```