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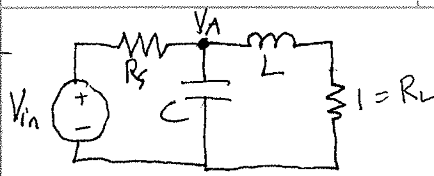

a.

$$H(s) = \frac{V_A}{V_{in}} \cdot \frac{V_{out}}{V_A} = \frac{V_{out}}{V_{in}}$$

$$\frac{V_A}{V_{in}} = V_{divider} \rightarrow \frac{\frac{1}{sC} \| (sL+1)}{\frac{1}{sC} \| (sL+1) + R_s} \cancel{V_{in}} = \frac{\frac{1}{sC + \frac{1}{sL+1}}}{R_s + \frac{1}{sC + \frac{1}{sL+1}}} \cancel{V_{in}} = \frac{1}{sR_sC + \frac{R_s}{Ls+1} + 1}$$

$$\frac{V_{out}}{V_A} = \overset{V_{divider2}}{\frac{1}{sL+1}}$$

$$\frac{V_{out}}{V_{in}} = \frac{1}{(sL+1)(sR_sC + \frac{R_s}{Ls+1} + 1)} = \frac{1}{s^2R_sCL + sR_sC + R_s + sL + 1}$$

$$= \frac{\frac{1}{R_sLC}}{s^2 + s\left[\frac{R_sC + L}{R_sLC}\right] + \frac{R_s+1}{R_sLC}} = \frac{\frac{1}{R_sLC}}{s^2 + s\left[\frac{1}{L} + \frac{1}{R_sC}\right] + \frac{1 + 1/R_s}{LC}} \checkmark$$

b. From table 21.1, 2nd order LP butterworth is of form:

$$s^2 + \sqrt{2}s + 1$$

Therefore $\frac{1}{L} + \frac{1}{R_sC} = \sqrt{2}$ & $\frac{1 + 1/R_s}{LC} = 1$ where $R_s = 2$

Solving, we get a quadratic equation with

Solution 1	Solution 2
$C \cong 1.67$ F	$C \cong 0.45$ F
$L \cong 0.90$ H	$L \cong 3.33$ H

c. $R_L = 2k\Omega$ $BW \overset{/\omega_c}{=} 5kHz$ (From Solution #2)

$K_m = 2k$ $K_f = 5k$

$R_{s_{new}} = 4k$
$R_{L_{new}} = 2k$
$L_{new} = 1800$ H
$C_{new} = 835 \mu F$
$BW_{new} = BW_{old} = 1Hz$

$\Rightarrow$

$$\boxed{\begin{aligned} R_{s_{Final}} &= R_{s_{new}} \\ R_{L_{Final}} &= R_{L_{new}} \\ L_{Final} &= 0.36 H \\ C_{Final} &= 167 nF \end{aligned}}$$

$BW_{Final} = BW_{old} \cdot 5000 = \boxed{5kHz}$