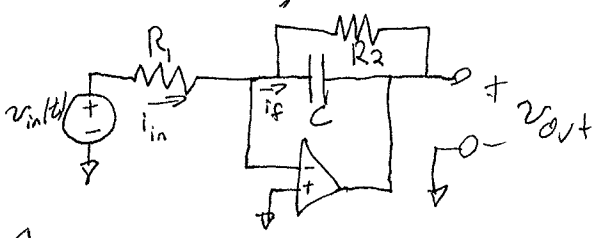
21



a.

$i_{in} = i_f$ $\qquad i_f = \dfrac{-v_{out}}{\frac{1}{R_2}+\frac{1}{sC}} = \dfrac{-v_{out}}{\frac{1}{R_2}+sC} = -v_{out}\left(sC+\frac{1}{R_2}\right)$

$i_{in} = \dfrac{v_{in}}{R_1}$

$-v_{out}\left(sC+\frac{1}{R_2}\right) = \dfrac{v_{in}}{R_1}$

$H(s) = \dfrac{v_{out}}{v_{in}} = \dfrac{-\frac{1}{R_1}}{sC+\frac{1}{R_2}} = \dfrac{-\frac{1}{R_1C}}{s+\frac{1}{R_2C}}$ ✓

b. $1 = \dfrac{1}{R_2C}$ & $1 = \dfrac{1}{R_1C}$ Pick $R_1 = R_2 = 1\Omega$, $C = 1F$

There are ∞ answers to this...

c. Given $C = 1nF$

Step 1: Frequency Scale

$K_f = 3500$

$C_{new} = \dfrac{1F}{3500} = 2.86e^{-4}F = \underline{286\mu F}$

$BW_{new} = 1Hz * 3500 = 3.5kHz$

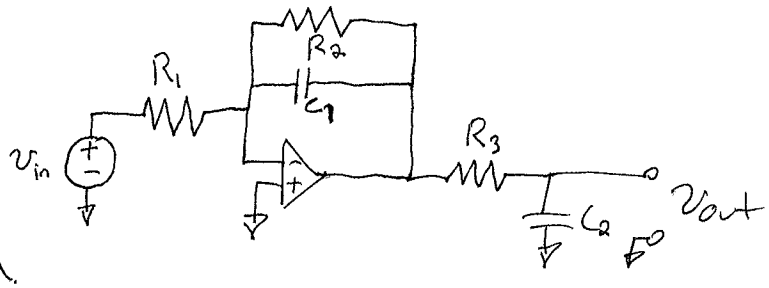
Step 2: Magnitude Scale

$C_{new} = 1nF = \dfrac{286\mu F}{K_m} \Rightarrow \boxed{K_m = 285,714}$ ← This answer depends on your answer to part (b)

$R_{1new} = 1\Omega \cdot K_m = \boxed{286k\Omega = R_1}$ ←

$R_{2new} = 1\Omega \cdot K_m = \boxed{286k\Omega = R_1}$ ←

L22



a.

$i_{in} = -i_f \longrightarrow \frac{v_{in}}{R_1} = -V_A\left(sC_1 + \frac{1}{R_2}\right)$

$i_{in} = \frac{v_{in}}{R_1}$

$i_f = V_A\left(sC_1 + \frac{1}{R_2}\right)$

$\frac{V_A}{v_{in}} = \frac{-1/R_1}{sC_1 + \frac{1}{R_2}} = \frac{\frac{-1}{R_1C_1}}{s + \frac{1}{R_2C_1}}$

$v_{out} = V_A \cdot \frac{\frac{1}{sC_2}}{\frac{1}{sC_2} + R_3} \Rightarrow \frac{v_{out}}{V_A} = \frac{\frac{1}{R_3C_2}}{s + \frac{1}{R_3C_2}}$

$H(s) = \frac{v_{out}}{v_{in}} = \frac{v_{out}}{V_A} \cdot \frac{V_A}{v_{in}} = \frac{\frac{1}{R_3C_2}}{s + \frac{1}{R_3C_2}} \cdot \frac{\frac{-1}{R_1C_1}}{s + \frac{1}{R_2C_1}} = \frac{\frac{-1}{R_3C_2R_1C_1}}{\left(s + \frac{1}{R_3C_2}\right)\left(s + \frac{1}{R_2C_1}\right)}$

b. $\frac{1}{R_3C_2R_1C_1} = 1$ & $\frac{1}{R_3C_2} = 1$ & $\frac{1}{R_2C_1} = 1$

$R_1 = R_2 = R_3 = 1\,\Omega$ $\quad C_1 = C_2 = 1\,F$

c. Step 1 Frequency scale

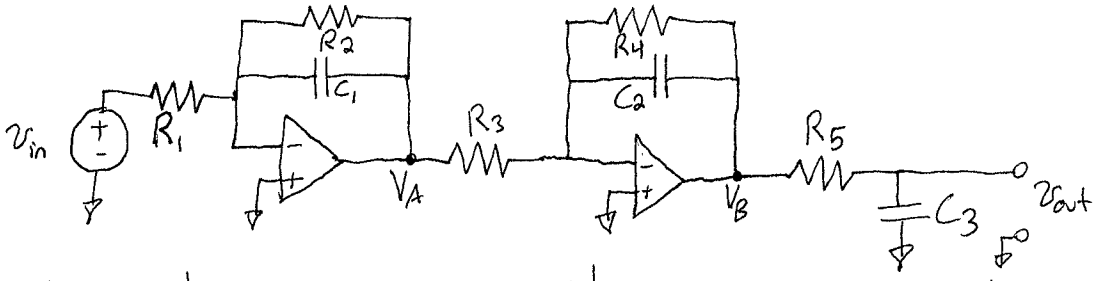
$\omega_{p\,old} = 1\,Hz = \frac{\omega_{p\,new}}{K_F}$ $\quad \omega_{p\,new} = 10^5\,rad/s \Rightarrow K_F = 10^5$

$C_{n\,new} = \frac{C_{n\,old}}{K_F} = 10\mu F = C_1 = C_2$

Step 2 Magnitude scale

Given: $C_{n\,new} = 1nF = \frac{C_{n\,old}}{K_m} \Rightarrow K_m = 10^4$

$R_{n\,new} = R_{n\,old} \cdot K_m = 10k = R_1 = R_2 = R_3$



$$\frac{V_A}{v_{in}} = \frac{\frac{-1}{R_1C_1}}{s+\frac{1}{R_2C_1}} \qquad \frac{V_B}{V_A} = \frac{\frac{-1}{R_3C_2}}{s+\frac{1}{R_4C_2}} \qquad \frac{v_{out}}{V_B} = \frac{\frac{1}{R_5C_3}}{s+\frac{1}{R_5C_3}}$$

$$H(s) = \frac{\frac{1}{R_1C_1R_3C_2R_5C_3}}{\left(s+\frac{1}{R_2C_1}\right)\left(s+\frac{1}{R_4C_2}\right)\left(s+\frac{1}{R_5C_3}\right)} \Rightarrow \frac{1}{R_2C_1} = \frac{1}{R_4C_2} = \frac{1}{R_5C_3} = 1$$

Set $R_2 = R_4 = R_5 = 1\Omega$
& $C_1 = C_2 = C_3 = 1F$

$$H(s) = \frac{\frac{1}{R_1R_3}}{(s+1)^3} \Rightarrow \frac{1}{R_1R_3} = 10 \Rightarrow \begin{matrix} R_1 = 0.1\,\Omega \\ R_2 = 1\,\Omega \end{matrix}$$

Frequency Scale

$\omega_{p\,new} = \omega_{p\,old} \cdot K_f \Rightarrow K_f = 10^5$

$C_{n\,new} = \frac{C_{n\,old}}{K_f} \Rightarrow C_1 = C_2 = C_3 = 10\mu F$

Magnitude Scale

$C_{n\,new} = 1nF = \frac{C_{n\,old}}{K_m} \Rightarrow K_m = 10^4 \quad C_1 = C_2 = C_3 = 1nF$

$R_{n\,new} = R_{n\,old} \cdot K_m \Rightarrow R_1 = 1k, \quad R_2 = R_3 = R_4 = R_5 = 10k\Omega$