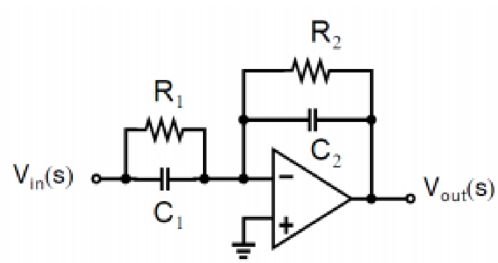
1.

$$V_{out}(s) = \frac{-1}{sC_2}\left[\left(1/R_1 + sC_1\right)V_{in}(s) + V_{out}(s)/R_2\right]$$

$$\frac{V_{out}(s)}{V_{in}(s)} = -\frac{R_2}{R_1}\frac{1+R_1C_1s}{1+R_2C_2s}$$

The opamp has a frequency response

$$A(s) = \frac{A_0}{1+\dfrac{sA_0}{\omega_{ta}}}$$



Denoting the negative opamp input terminal voltage, V_x, we may write a nodal equation there as follows:

$$\frac{V_{in}-V_x}{R_1 \| 1/sC_1} = \frac{V_x - V_{out}}{R_2 \| 1/sC_2}$$

Substituting in $V_{out} = -A(s)V_x \Rightarrow V_x = -V_{out}/A(s)$:

$$\frac{V_{in}+V_{out}/A(s)}{R_1 \| 1/sC_1} = \frac{-V_{out}/A(s) - V_{out}}{R_2 \| 1/sC_2}$$

Using the expression for $A(s)$ above and rearranging yields:

$$\frac{V_{out}(s)}{V_{in}(s)} = -\frac{R_2}{R_1}\frac{A_0}{1+A_0}\frac{1+R_1C_1s}{1+R_2C_2s}\frac{1}{1+s/\omega_{ta}}$$

2. KCL at C_1: - gm1.V1 - gm2.V2 + gm4.Vo = sC1.V2

   KCL at C2: - gm3.V2 = sC2.Vo

   Ho(s) = Vo/V1 = gm1.gm3 / (s^2.C1.C2 + s.gm2.C2 + gm3.gm4)

   H1(s) = V2/V1 = (-sC2 / gm3) Ho(s) = - sC2.gm1 / (s^2.C1.C2 + s.gm2.C2 + gm3.gm4)

3. By interreciprocity, $Vo = -\sum I'_k V_k$. Using Bashkow's method, we assume $I'_1 = 1$ A, and also to simplify the calculations, R = 1 (this doesn't change the voltage gain). Then $V_a' = 2$, $I_2' = 2$, $I_b' = 3$, $V_b' = 5$ $I_3' = 5$, $I_c' = 8$, $V_c' = 13$, $I_4' = 13$, $I_d' = 21$.

Hence, the scale factor is -1/21, and $V_o = (1/21)$ [1x1 + 2x1 +5x2 + 13x2] = 39/21 ~ 1.857 V.