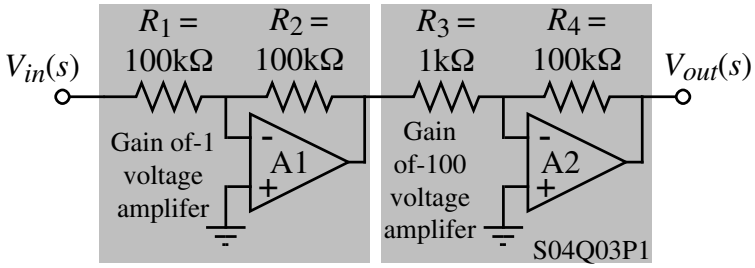
**QUIZ NO. 3 - SOLUTION**

(Average score = 5.4/10 of those taking the quiz.)

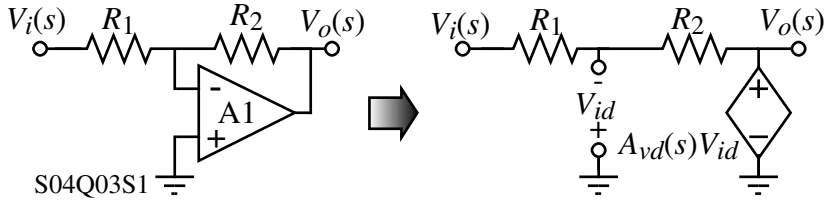
A voltage amplifier having a gain of +100 is made by cascading two inverting op amp voltage amplifiers as shown. Find the values of the poles of this amplifier (there is one for each inverting amplifier) and the –3dB frequency of the overall amplifier in Hz if both op amps have a differential voltage gain given as




$$\frac{V_o(s)}{V_{id}(s)} = A_{vd}(s) = \frac{GB}{s+\omega_a} = \frac{10^7}{s+100}$$

*Solution*

Find the frequency response of a general inverting amplifier using the model below.




Using superposition, we can write that,

$$V_o(s) = -A_{vd}(s)\left[\left(\frac{R_1}{R_1+R_2}\right)V_o(s) + \left(\frac{R_2}{R_1+R_2}\right)V_i(s)\right]$$

$$V_o(s)\left[1+A_{vd}(s)\left(\frac{R_1}{R_1+R_2}\right)\right] = -A_{vd}(s)\left(\frac{R_2}{R_1+R_2}\right)V_i(s) \quad \rightarrow \quad \frac{V_o(s)}{V_i(s)} = \frac{-\frac{R_2}{R_1+R_2}}{\frac{1}{A_{vd}(s)} + \frac{R_1}{R_1+R_2}}$$

$$\therefore \quad \frac{V_o(s)}{V_i(s)} = \frac{-GB\left(\frac{R_2}{R_1+R_2}\right)}{s+\omega_a + GB\left(\frac{R_1}{R_1+R_2}\right)} \approx \frac{-GB\left(\frac{R_2}{R_1+R_2}\right)}{s+GB\left(\frac{R_1}{R_1+R_2}\right)} \quad \rightarrow \quad \text{Pole} = -GB\left(\frac{R_1}{R_1+R_2}\right)$$

So the poles are $p_1 = -10^7\left(\frac{1}{2}\right) = \underline{-5\text{x}10^6 \text{ rads/sec.}}$ and $p_2 = -10^7\left(\frac{1}{101}\right) \approx \underline{-10^5 \text{ rads/sec.}}$

The –3dB frequency is $f_{-3\text{dB}} = \frac{|p_2|}{2\pi} = \underline{15.9\text{kHz}}$