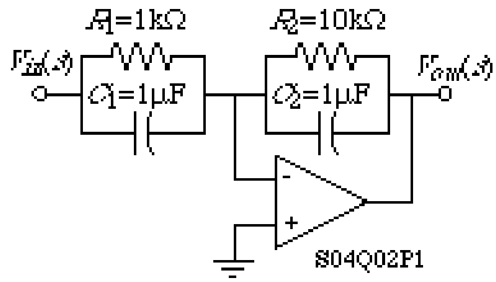
QUIZ NO. 2

(Average score = 7.4/10 of those taking the quiz.)

A circuit using an ideal op amp is shown.

(a.) Find the *s*-domain transfer function, $V_{out}(s)/V_{in}(s)$ and solve for the numerical values of all roots.

(b.) Assuming the answer to part (a.) is given below, sketch an asymptotic magnitude and phase frequency response of this transfer function.



$$\frac{V_{out}(s)}{V_{in}(s)} = -10\left(\frac{s+100}{s+10}\right)$$

Solution

(a.) The easiest way to get the transfer function is to remember the generalized form which is,

$$\frac{V_{out}(s)}{V_{in}(s)} = -\frac{Z_2(s)}{Z_1(s)}$$

where $Z_2(s) = \frac{R_2(1/sC_2)}{R_2 + (1/sC_2)} = \frac{R_2}{sC_2R_2 + 1}$ and $Z_1(s) = \frac{R_1(1/sC_1)}{R_1 + (1/sC_1)} = \frac{R_1}{sC_1R_1 + 1}$

Thus,

$$\frac{V_{out}(s)}{V_{in}(s)} = -\left(\frac{R_2}{R_1}\right)\frac{sC_1R_1 + 1}{sC_2R_2 + 1} = -10\left(\frac{\frac{s}{1000} + 1}{\frac{s}{100} + 1}\right) \quad \rightarrow$$

Pole at <u>-100 rads/s</u>

Zero at -<u>1000 rads/s</u>

(b.) If $\frac{V_{out}(s)}{V_{in}(s)} = A_v(s) = -10\left(\frac{s+100}{s+10}\right) = -100\left(\frac{\frac{s}{100}+1}{\frac{s}{10}+1}\right)$, the magnitude and phase are

$$|A_v(j\omega)| = 20\log_{10}(100) + 20\log_{10}\sqrt{1+\left(\frac{\omega}{100}\right)^2} - 20\log_{10}\sqrt{1+\left(\frac{\omega}{10}\right)^2}$$

$$\text{Arg}[A_v(j\omega)] = \pm 180° + \tan^{-1}\left(\frac{\omega}{100}\right) - \tan^{-1}\left(\frac{\omega}{10}\right)$$

Plotting gives,