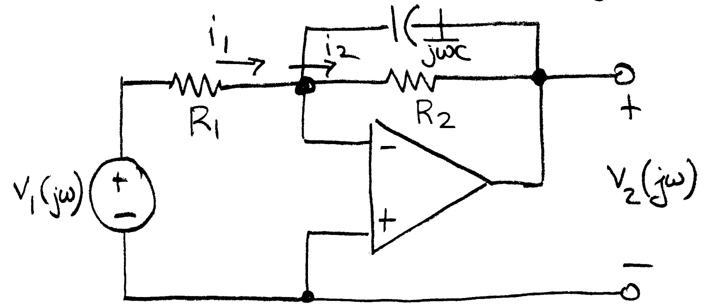
Design Example 12-3

Show that the transfer function $T(j\omega) = \dfrac{V_2(j\omega)}{V_1(j\omega)}$ in the circuit shown below has a low-pass gain characteristic.



Do KCL at inverting input. Voltage at inverting input is 0 volts.

$$i_1 = \frac{V_1(j\omega) - 0}{R_1} = \frac{V_1(j\omega)}{R_1}$$

$$Z_{EQ} = R_2 \parallel \frac{1}{j\omega C} = \frac{R_2/j\omega C}{R_2 + \frac{1}{j\omega C}} = \frac{R_2}{j\omega R_2 C + 1}$$

$$i_2 = \frac{0 - V_2(j\omega)}{Z_{EQ}} = \frac{-V_2(j\omega)}{\frac{R_2}{1 + j\omega R_2 C}} = -\frac{(1 + j\omega R_2 C)\, V_2(j\omega)}{R_2}$$

$\sum i = 0$ $+i_1 - i_2 = 0$

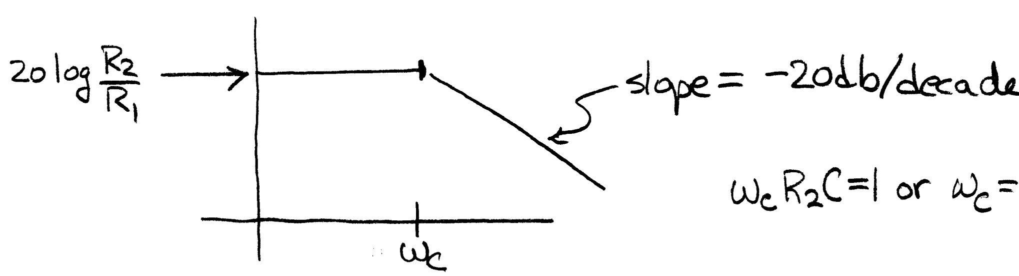
+in

$$i_1 = i_2$$

$$\frac{V_1(j\omega)}{R_1} = -\frac{(1 + j\omega R_2 C)\, V_2(j\omega)}{R_2}$$

$$T(j\omega) = \frac{V_2(j\omega)}{V_1(j\omega)} = -\frac{R_2/R_1}{1 + j\omega R_2 C}$$

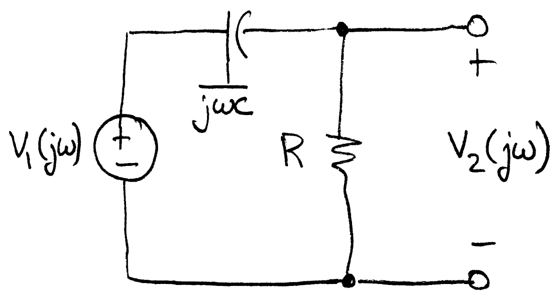
$$20 \log |T(j\omega)| = 20 \log\left(\frac{R_2}{R_1}\right) - 20 \log (1 + \omega R_2 C)$$



$\omega_c R_2 C = 1$ or $\omega_c = \dfrac{1}{R_2 C}$

Example 12-5

Show that the transfer function $T(j\omega) = \dfrac{V_2(j\omega)}{V_1(j\omega)}$ shown in the circuit below has a high-pass gain response. Construct the straight-line approximations to the gain response of the circuit.

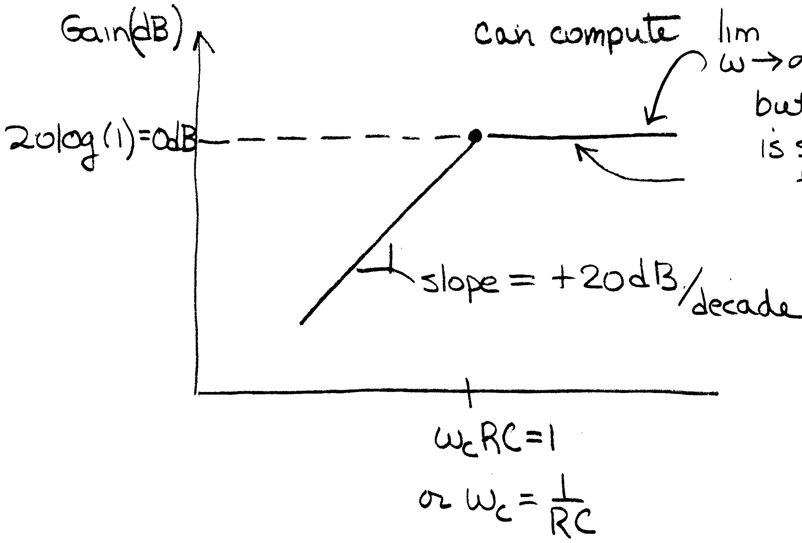


Using voltage division $\quad V_2(j\omega) = \dfrac{R}{R + \frac{1}{j\omega C}} V_1(j\omega)$

$$\frac{V_2(j\omega)}{V_1(j\omega)} = \frac{R}{R + \frac{1}{j\omega C}} = \frac{j\omega RC}{j\omega RC + 1}$$

$$20\log_{10}|T(j\omega)| = 20\log_{10}|\omega RC| - 20\log_{10}|1 + j\omega RC|$$

This is harder to plot.



can compute $\lim_{\omega \to \infty} \left| \dfrac{j\omega RC}{1 + j\omega RC} \right| = 1$

but +20db/dec from numerator is simply canceled by −20db/decade from numerator!

from numerator

$20\log_{10}|\omega RC| = 0$ @ $\omega = 0$

and has slope +20db/decade