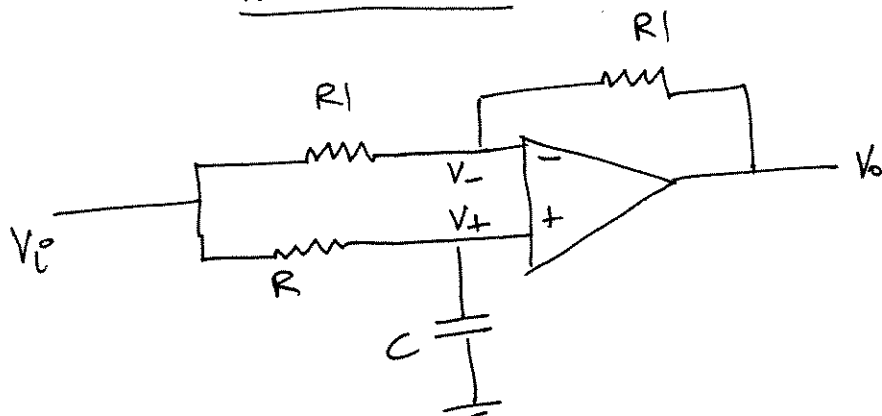


Homework #1

Q.1

(a)



$$\frac{V_i - V_-}{R_1} = \frac{V_- - V_o}{R_1} \Rightarrow V_- = \frac{V_i + V_o}{2} \rightarrow \textcircled{1}$$

$$\frac{V_i - V_+}{R} = \frac{V_+}{1/sC} \Rightarrow V_i - V_+ = sRCV_+ \Rightarrow V_+ = \frac{V_i}{(1+sRC)} \rightarrow \textcircled{2}$$

Ideal Opamp $V_+ = V_-$

$$\Rightarrow \frac{V_i + V_o}{2} = \frac{V_i}{(1+sRC)}$$

$$\Rightarrow V_o = 2V_i \left[\frac{1}{(1+sRC)} - \frac{1}{2} \right]$$

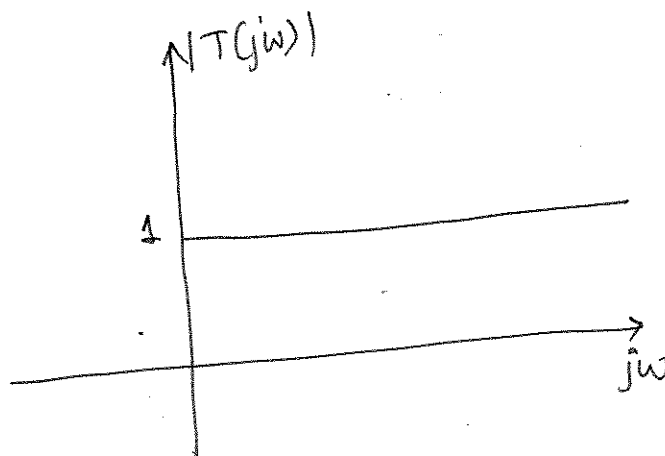
$$\Rightarrow T(s) = \frac{V_o}{V_i} = \frac{2[2 - 1 - sRC]}{2(1+sRC)} = \frac{1-sRC}{1+sRC}$$

$$\Rightarrow T(j\omega) = \frac{1-j\omega RC}{1+j\omega RC}$$

$$|T(j\omega)| = \left| \frac{1-j\omega RC}{1+j\omega RC} \right|$$

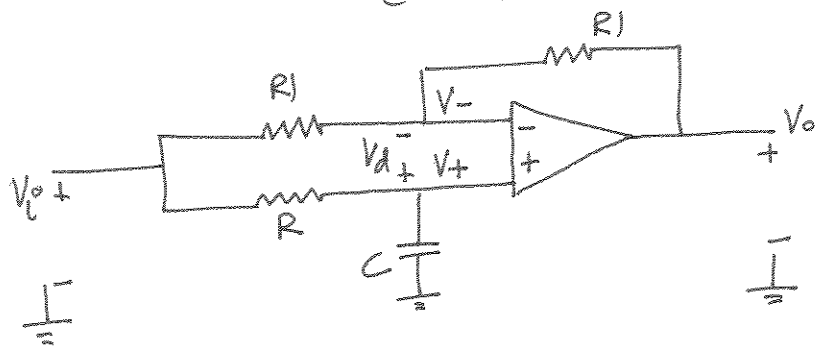
$$= 1$$

Constant Magnitude



(b)

$$V_o(s) = \left[\frac{K}{(1+s/\omega_0)} \right] V_d(s)$$



$$V_d = V_+ - V_-$$

$$\frac{V_i - V_-}{R_1} = \frac{V_- - V_o}{R_1} \Rightarrow V_- = \frac{V_i + V_o}{2}$$

$$\frac{V_i - V_+}{R} = \frac{V_+}{1/sC} \Rightarrow V_i - V_+ = sRC V_+ \Rightarrow V_+ = \frac{V_i}{(1+sRC)}$$

$$V_+ - V_- = \frac{V_i}{(1+sRC)} - \frac{V_i + V_o}{2} = \frac{2V_i - V_i - sRC V_i - (1+sRC)V_o}{2(1+sRC)}$$

$$V_d = \frac{(1-sRC)V_i - (1+sRC)V_o}{2(1+sRC)} = \frac{(1+s/\omega_0)}{K} V_o$$

$$\Rightarrow K(1-sRC)V_i - K(1+sRC)V_o = 2(1+sRC)(1+s/\omega_0)V_o$$

$$\Rightarrow T(s) = \frac{V_o}{V_i} = \left[\frac{K(1+sRC) + 2(1+sRC)(1+s/\omega_0)}{K(1-sRC)} \right]^{-1}$$

$$= \frac{K(1-sRC)}{K(1+sRC) + 2(1+sRC)(1+s/\omega_0)}$$