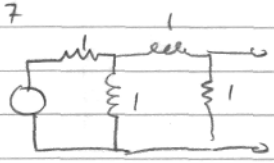
HW #6

1. 14.-57

b)

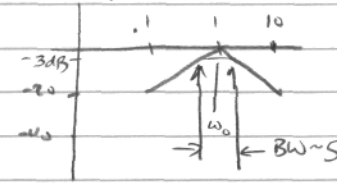


$$H(s) = \left(\frac{1}{1+1s}\right)\left(\frac{1s}{1+1s}\right)$$

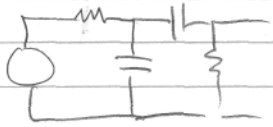
$$= \frac{s}{(1+s)^2}$$

center at $\omega = 1$

$BW \simeq 5$



c)

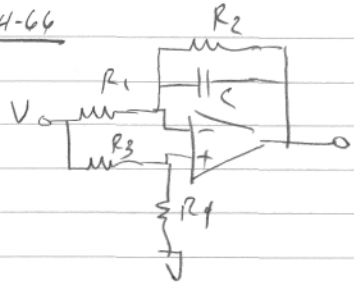


$$H(\omega) = \left(\frac{1}{1+\frac{1}{s}}\right)\left(\frac{1/s}{1+\frac{1}{s}}\right)$$

$$= \left(\frac{s}{s+1}\right)\left(\frac{1}{s+1}\right) = \frac{s}{(1+s)^2}$$

SAME AS ABOVE

2. 14-66



$$V_o = V_- - I\left(\frac{1}{R_2} + \frac{sC}{R_2}\right)^{-1} = V_- - I\,\frac{R_2}{1+sR_2C}$$

$$V_- = V_1\,\frac{R_4}{R_3+R_4}$$

$$I = \frac{V_1 - V_-}{R_1}$$

$$V_o = V_1\,\frac{R_4}{(R_3+R_4)} - \frac{(V_1-V_-)}{R_1}\,\frac{R_2}{(1+sR_2C)}$$

$$= V_1\,\frac{R_4}{(R_3+R_4)} - V_1\,\frac{R_2}{R_1}\,\frac{1}{(1+sR_2C)} + V_-\,\frac{R_2}{R_1}\,\frac{1}{(1+sR_2C)}$$

$$= V_1\left[\frac{R_4}{(R_3+R_4)} - \frac{R_2}{R_1}\,\frac{1}{(1+sR_2C)}\right] + V_1\,\frac{R_4}{(R_3+R_4)}\,\frac{R_2}{R_1}\,\frac{1}{(1+sR_2C)}$$

$$\frac{V_o}{V_1} = \frac{R_4}{(R_3+R_4)}\left[1 + \frac{R_2}{R_1}\,\frac{1}{(1+sR_2C)}\right] - \left(\frac{R_2}{R_1}\,\frac{1}{(1+sR_2C)}\right)$$

$$\times \frac{R_4}{(R_3+R_4)}\left(\frac{R_3+R_4}{R_4}\right)$$

$$\frac{V_o}{V_i} = \frac{R_4}{R_3+R_4}\left[1 + \frac{R_2}{R_1}\frac{1}{(1+sR_2C)}\left(1 - 1 - \frac{R_3}{R_4}\right)\right]$$

$$= \frac{R_4}{R_3+R_4}\left[1 - \frac{R_2}{R_1}\frac{R_3}{R_4}\frac{1}{(1+sR_2C)}\right]$$

$$= \frac{R_4}{R_3+R_4}\left[\frac{1 + sR_2C - \frac{R_2}{R_1}\frac{R_3}{R_4}}{1+sR_2C}\right]$$

$$= \frac{R_4}{R_3+R_4}\left[\frac{s + \frac{1}{R_2C} - \frac{R_3}{CR_1R_4}}{s + \frac{1}{R_2C}}\right]$$

$$= \frac{R_4}{R_3+R_4}\left[\frac{s + \frac{1}{R_1C}\left(\frac{R_1}{R_2} - \frac{R_3}{R_4}\right)}{s + 1/R_2C}\right]$$

QED

b. FOR HIGH PASS

FORM $\dfrac{(\quad)}{\frac{s}{\omega_0}+1}$ MUST BE MET, SO TERMS IN ( ) MUST $\to 0$

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

c. FOR LOW PASS

$\dfrac{1}{\left(\frac{s}{\omega_0}+1\right)}$ MUST BE MET $\therefore$ $(\quad) \gg 1$

$$\frac{R_1}{R_2} \gg \frac{R_3}{R_4}$$

3. Zero @ origin
Pole @ 1 kHz = 159 s^{-1}) HIGH PASS PORTION
Double pole at 10 kHz = 1.59×10^3 s^{-1}) LOW PASS PORTION

$$H(\omega) = \left(\text{HP} \right)\left(\text{LP} \right)$$

$$= \left[\frac{s/159}{\left(1 + \frac{s}{159}\right)} \right] \frac{1}{\left(1 + \frac{s}{1.59k}\right)^2}$$

ω_1 ω_2

$$\omega_1 = \frac{1}{R_1 C_1} \qquad \omega_2 = \frac{1}{R_2 C_2}$$