1. Equation of the RC Circuit.

$$RC\frac{dV_c}{dt} + V_c = V_i$$

$$RCS\,V_c(s) + V_c(s) = V_i(s)$$

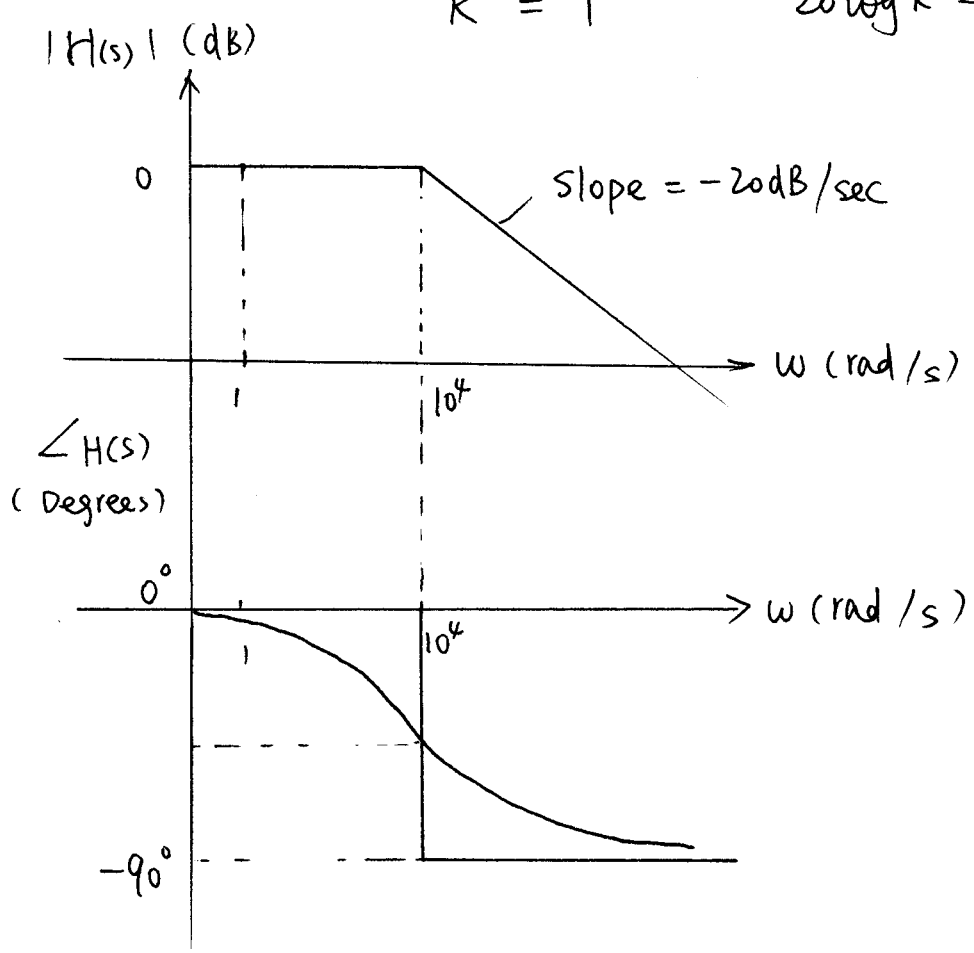
$$\therefore \frac{V_c(s)}{V_i(s)} = \frac{1}{RCS+1} = \frac{1}{\frac{S}{\frac{1}{RC}}+1}$$

$$R = 1k\Omega, \quad C = 0.1\mu F \qquad RC = 10^{-4}$$

$$\therefore H(S) = \frac{1}{\frac{S}{10^4}+1}$$

break point frequency is 10^4 rad/sec

Bode plot: $k = 1$ $\qquad 20\log k = 0$



2. Equation of RC band-pass filter

$$\begin{cases} C_1 \dfrac{dV_{C_1}}{dt} = \dfrac{V_{C_2}}{R_2} + C_2 \dfrac{dV_{C_2}}{dt} & (1) \\ V_{C_2} + V_{C_1} + R_1 C_1 \dfrac{dV_{C_1}}{dt} = V_1 & (2) \end{cases}$$

(1) $\Rightarrow$ $R_2 S C_1 V_{C_1}(s) = V_{C_2}(s) + S R_2 C_2 V_{C_2}(s)$

$$\Rightarrow V_{C_1} = \frac{1+SR_2C_2}{R_2SC_1} V_{C_2} \qquad (3)$$

(2),(3) $\Rightarrow$ $V_{C_2}(s) + \dfrac{1+SR_2C_2}{R_2SC_1} V_{C_2}(s) + R_1C_1 S \cdot V_{C_2}(s) \dfrac{1+SR_2C_2}{R_2SC_1} = V_1(s)$

$$\left[1 + \frac{1+SR_2C_2}{R_2SC_1} + \frac{R_1}{R_2}(1+SR_2C_2)\right] V_{C_2}(s) = V_1(s)$$

$$\therefore H(s) = \frac{V_{C_2}(s)}{V_1(s)} = \frac{R_2SC_1}{R_2SC_1 + 1 + SR_2C_2 + SC_1R_1(1+R_2SC_2)}$$

$$= \frac{R_2SC_1}{S^2 R_1R_2C_1C_2 + S(R_1C_1 + R_2C_2 + R_2C_1) + 1}$$

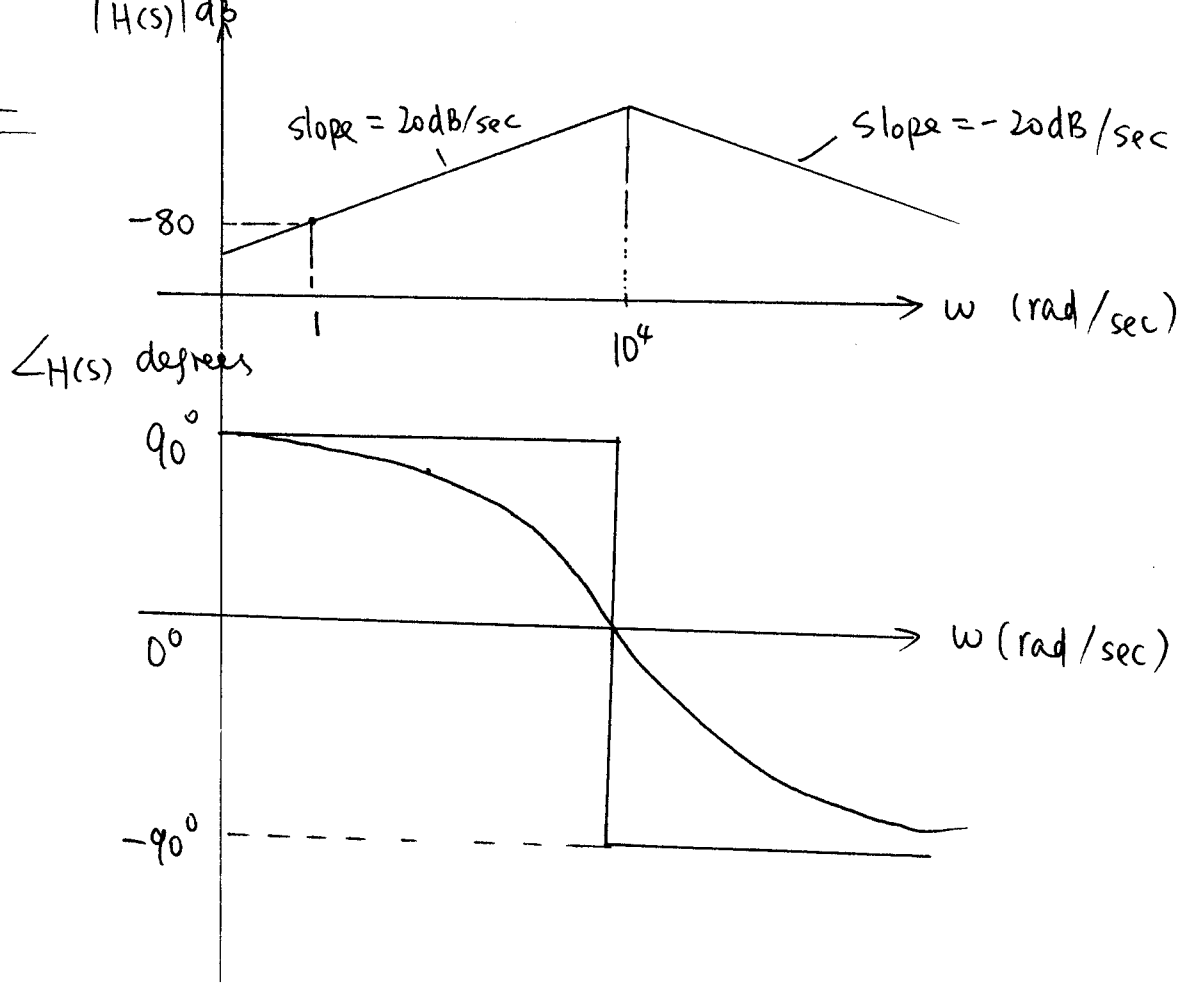
$R_1 = R_2 = 1\,K\Omega$, $\quad C_1 = C_2 = 10^{-7}\,F$

$$\therefore H(s) = \frac{10^{-4} \cdot S}{\frac{S^2}{10^8} + \frac{S}{\frac{1}{3}\times 10^4} + 1} = \frac{10^{-4} \cdot S}{\frac{S^2}{10^8} + \frac{S}{\frac{10^4}{3}} + 1}$$

$\therefore$ break point frequency is 10^4 rad/sec.

$k = 10^{-4}$ $\qquad 20 \log k = -80$ dB

Bode plot:



3. Equation of RLC Circuit

$$\begin{cases} V_{in} = L \cdot \dfrac{di_L}{dt} + V_o & (1) \\ i_L = \dfrac{V_o}{R} + C\dfrac{dV_o}{dt} & (2) \end{cases}$$

(1) $\Rightarrow$ $V_{in}(s) = sL\,i_L(s) + V_o(s)$ (3)

(2) $\Rightarrow$ $i_L(s) = \dfrac{V_o(s)}{R} + sC\,V_o(s)$ (4)

(3) $\to$ (4) $\Rightarrow$ $V_{in}(s) = LS\left(\dfrac{V_o(s)}{R} + sCV_o(s)\right) + V_o(s)$

$$= \left(\frac{L}{R}s + LCs^2 + 1\right) V_o(s)$$

$$\therefore H(s) = \frac{V_o(s)}{V_{in}(s)} = \frac{1}{\dfrac{s}{\frac{R}{L}} + \dfrac{s^2}{\frac{1}{LC}} + 1}$$

$C = 10^{-7}\ F, \quad R = 10^3\ \Omega, \quad L = 0.4\ H$

$$\therefore H(s) = \frac{1}{\frac{s^2}{\frac{10^8}{4}} + \frac{s}{\frac{10^4}{4}} + 1}$$

$\therefore$ break point frequency is $\frac{10^4}{2} = 5 \times 10^3$ rad/sec

$k = 1 \qquad 20 \log k = 0$

Bode plot: