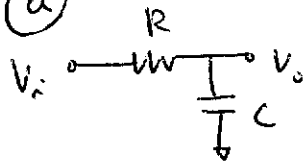


2000년 1학기 계측회로 II 중간고사

1. (a)

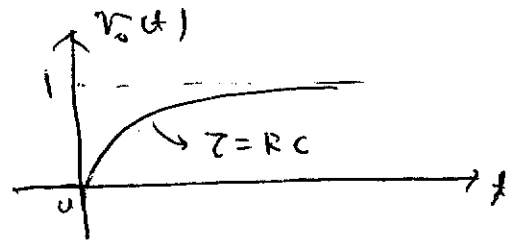
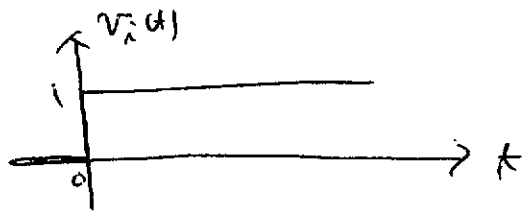
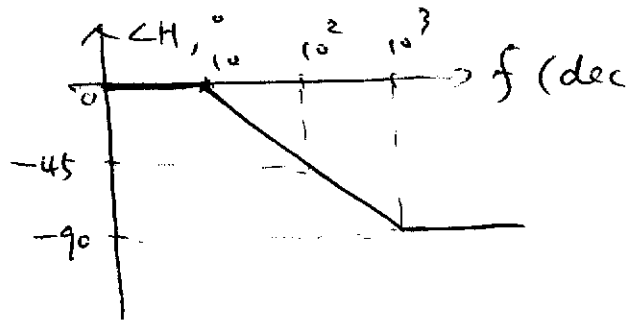
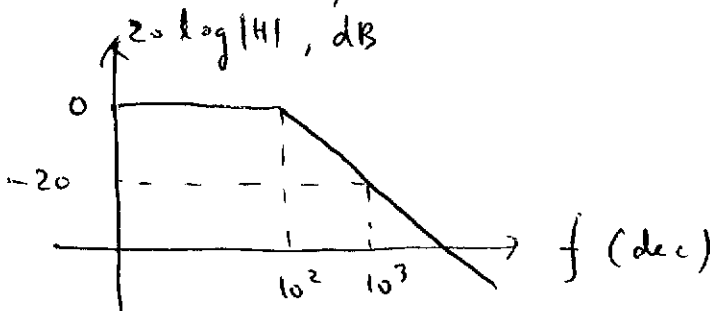


$$V_o = \frac{\frac{1}{sC}}{R + \frac{1}{sC}} V_i = \frac{1}{1 + sRC} V_i$$

$$H(s) = \frac{V_o}{V_i} = \frac{1}{1 + sRC}$$

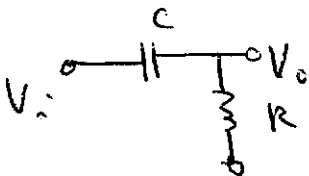
$$H(j\omega) = \frac{1}{1 + j\omega RC} = \frac{1}{1 + j\omega/\omega_0}$$

$$\omega_0 = \frac{1}{RC}, \quad f_0 = \frac{1}{2\pi RC} \doteq 100 \text{ Hz}$$



at $f = f_0$, $\angle H = \angle\left(\frac{1}{1+j}\right) = -45^\circ$

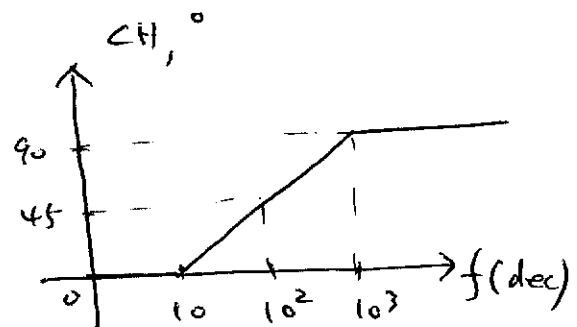
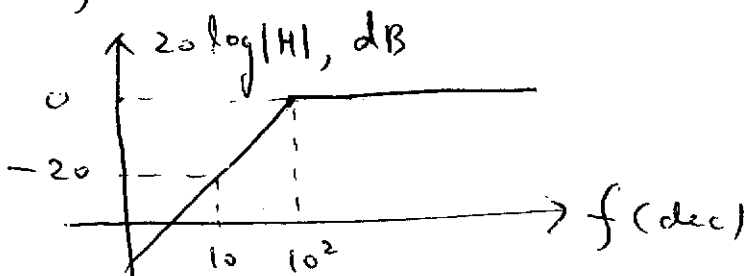
(b)

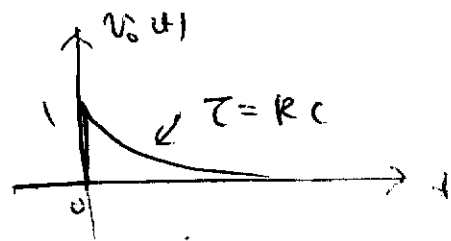
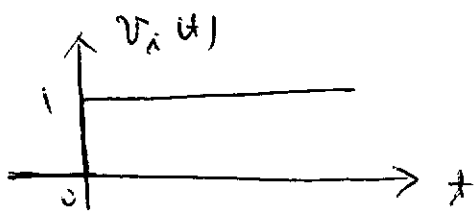


$$V_o = \frac{R}{\frac{1}{sC} + R} V_i = \frac{sRC}{1 + sRC} V_i$$

$$H(j\omega) = \frac{j\omega RC}{1 + j\omega RC} = \frac{j\omega/\omega_0}{1 + j\omega/\omega_0}, \quad \omega_0 = \frac{1}{RC}$$

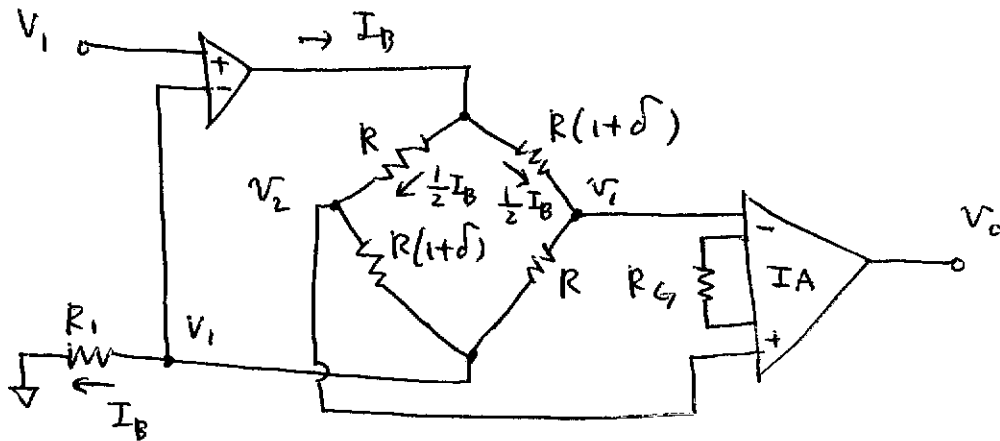
$$f_0 = \frac{1}{2\pi RC} \doteq 100 \text{ Hz}$$





at $f = f_0$, $\angle H = \angle \left(\frac{j}{1+j} \right) = 45^\circ$

2.



$$\delta = \alpha \Delta T = 0.00392 \Delta T$$

$$P_{RTD} = \left(\frac{1}{2} I_B \right)^2 R = \frac{R}{4} I_B^2 = 0.2 \times 10^{-3} \text{ W}$$

$$R = 100 \Omega \text{ 이므로 } I_B = 2.83 \text{ mA}$$

$$\text{따라서, } I_B = 2.5 \text{ mA} \text{ 를 선택. 그러면, } I_B = \frac{V_i}{R_1} \text{ 였다}$$

$$V_i = 5 \text{ V, } R_1 = 2 \text{ k}\Omega \text{ 를 선택.}$$

$$v_2 = V_i + R(1+\delta) \frac{1}{2} I_B, \quad v_1 = V_i + R \frac{1}{2} I_B$$

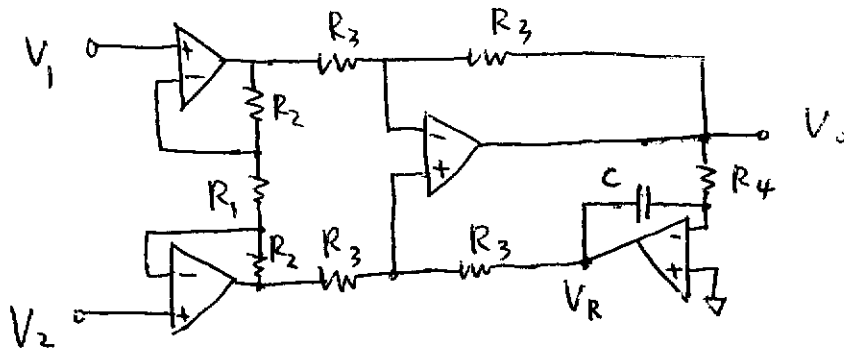
$$v_o = A_{DM} (v_2 - v_1) = A_{DM} R \delta \frac{1}{2} I_B$$

$$= A_{DM} \times 100 \times 0.00392 \Delta T \times \frac{1}{2} \times 2.5 \times 10^{-3}$$

$$\frac{v_o}{\Delta T} = 0.1 \text{ mV/K} \quad A_{DM} = 204.08$$

$$A_{DM} = \frac{49400}{R_G} + 1 \text{ 였다} \quad R_G = 243.3 \Omega$$

3.



$$V_R = - \frac{1}{sC R_4} V_o = - \frac{1}{sR_4 C} V_o$$

26 स्थिति में माना जाये

① $V_R = 0$ के लिए, $V_o = \left(1 + 2 \frac{R_2}{R_1}\right) (V_2 - V_1)$

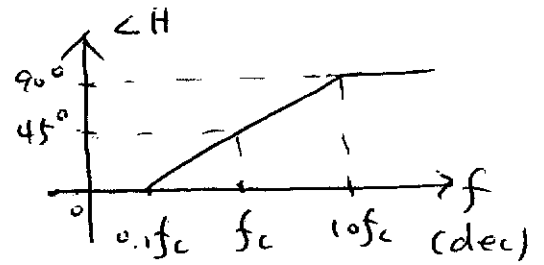
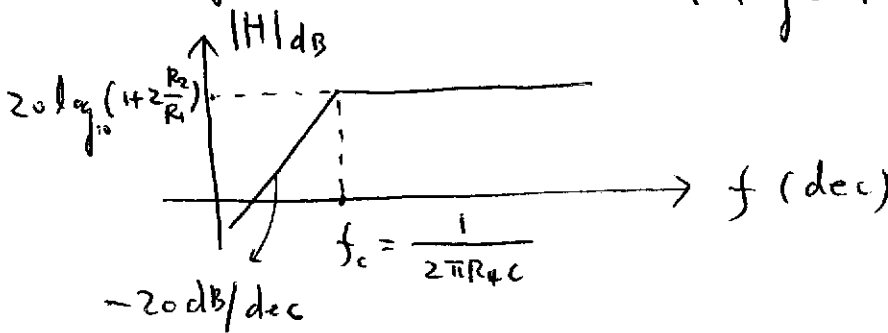
② $V_2 = V_1 = 0$ के लिए, $V_o = \frac{1}{2} V_R \times 2 = V_R$

$$V_o = \left(1 + 2 \frac{R_2}{R_1}\right) (V_2 - V_1) - \frac{1}{sR_4 C} V_o$$

$$\frac{1 + sR_4 C}{sR_4 C} V_o = \left(1 + 2 \frac{R_2}{R_1}\right) (V_2 - V_1)$$

$$H(s) = \frac{V_o}{V_2 - V_1} = \left(1 + 2 \frac{R_2}{R_1}\right) \frac{sR_4 C}{1 + sR_4 C}$$

$$H(j\omega) = \left(1 + 2 \frac{R_2}{R_1}\right) \frac{j\omega R_4 C}{1 + j\omega R_4 C}$$



$$A_{DM} = 1 + 2 \frac{R_2}{R_1} = 100 \text{ m.k.}$$

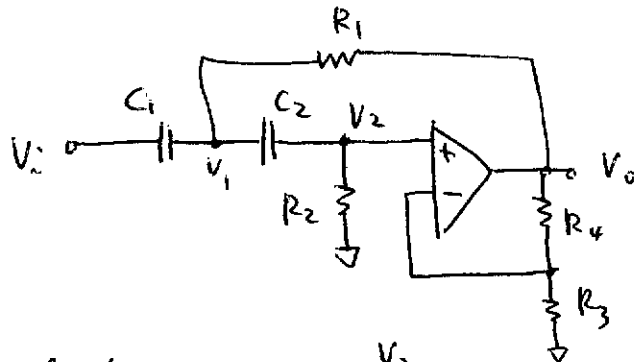
$$R_2 = 49.5 \text{ k}\Omega, R_1 = 1 \text{ k}\Omega$$

$$f_c = \frac{1}{2\pi R_4 C} = 0.5 \text{ m.k.} \quad C = 1 \mu\text{F}, R_4 = 318.3 \text{ k}\Omega$$

$$R_3 = 10 \text{ k}\Omega \quad \text{10}\%$$

A_{CM} 의 측정 : v_1 과 v_2 모두에 $5V_{PP}$, $60Hz$ 정현파를 입력하고, v_o 의 $60Hz$ 성분 정현파의 P-P 전압을 측정한다. 그러면, $A_{CM} = \frac{V_{o,PP}}{5}$ 이다.

4.



$$K = 1 + \frac{R_4}{R_3}$$

$$V_2 = \frac{V_o}{K}$$

$$sC_2(v_1 - v_2) = \frac{v_2}{R_2} \implies sC_2R_2v_1 = (1 + sC_2R_2)v_2$$

$$v_1 = \frac{1 + sC_2R_2}{sC_2R_2} \cdot \frac{V_o}{K}$$

$$sC_1(v_i - v_1) = sC_2(v_1 - v_2) + \frac{v_1 - v_o}{R_1}$$

$$sC_1R_1v_i = (sC_1R_1 + sC_2R_1 + 1)v_1 - sC_2R_1v_2 - V_o$$

$$= \frac{[s(C_1R_1 + C_2R_1) + 1](sC_2R_2 + 1)}{sC_2R_2} \cdot \frac{V_o}{K} - sC_2R_1 \frac{V_o}{K} - V_o$$

$$= \frac{V_o}{K} \frac{s^2C_1C_2R_1R_2 + s[(1-K)C_2R_2 + C_1R_1 + C_2R_1] + 1}{sC_2R_2}$$

$$H(s) = \frac{V_o}{v_i} = K \frac{s^2C_1C_2R_1R_2}{1 + s[(1-K)C_2R_2 + C_1R_1 + C_2R_1] + s^2C_1C_2R_1R_2}$$

$$H(j\omega) = K \frac{-\omega^2C_1C_2R_1R_2}{1 + j\omega[(1-K)C_2R_2 + C_1R_1 + C_2R_1] - \omega^2C_1C_2R_1R_2}$$

$\frac{1}{\sqrt{2}}$ 준형 $H(j\omega)$ 에 비례하면,

$$\omega_0 = \frac{1}{\sqrt{C_1C_2R_1R_2}} \quad H_{0HP} = K = 1 + \frac{R_4}{R_3}$$

$$Q = \frac{1}{(1-K) \sqrt{R_2C_2/R_1C_1} + \sqrt{R_1C_2/R_2C_1} + \sqrt{R_1C_1/R_2C_2}}$$

Equal component design in $\omega \geq \omega_0$,

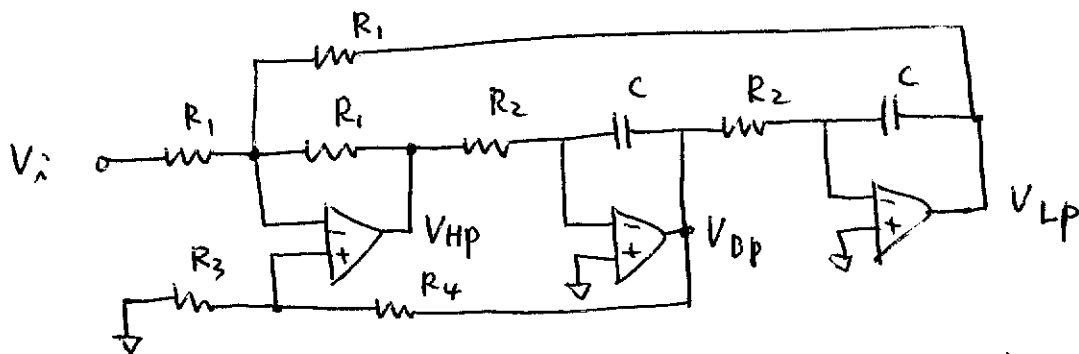
$$C_1 = C_2 = C, \quad R_1 = R_2 = R$$

$$f_0 = \frac{1}{2\pi RC} = 100, \quad \theta = \frac{1}{3-k} = 0.707$$

$$RC = \frac{1}{200\pi}, \quad k = 1 + \frac{R_4}{R_3} = 1.5856$$

$$C = 100 \text{ nF}, \quad R = 16 \text{ k}\Omega, \quad R_3 = 1 \text{ k}\Omega, \quad R_4 = 585.6 \Omega$$

5.



$$V_{BP} = -\frac{1}{sR_2C} V_{HP}, \quad V_{LP} = -\frac{1}{sR_2C} V_{BP}$$

$$V_{HP} = -V_i - V_{LP} + (1 + \frac{R_4}{R_3}) V_{BP}$$

$$= -V_i - V_{LP} + \frac{3}{1 + \frac{R_4}{R_3}} V_{BP}$$

$$k = \frac{3}{1 + \frac{R_4}{R_3}} \approx \frac{3}{1.5856}$$

$$\begin{aligned} \textcircled{1} V_i &= k V_{BP} + \frac{1}{sR_2C} V_{BP} + sR_2C V_{BP} \\ &= \frac{1 + s k R_2 C + s^2 R_2^2 C^2}{s R_2 C} V_{BP} \end{aligned}$$

$$H_{BP}(j\omega) = \frac{j\omega R_2 C}{1 + j\omega k R_2 C - \omega^2 R_2^2 C^2} \quad \omega \geq \omega_0$$

$$\omega_0 = \frac{1}{R_2 C}, \quad \theta = \frac{1}{k} = \frac{1}{3} \left(1 + \frac{R_4}{R_3}\right), \quad H_{0BP} = \theta$$

$$\begin{aligned} \textcircled{2} \quad V_i &= -K s R_2 C V_{LP} - V_{LP} - s^2 R_2^2 C^2 V_{LP} \\ &= - \left[s K R_2 C + 1 + s^2 R_2^2 C^2 \right] V_{LP} \end{aligned}$$

$$H_{LP}(j\omega) = \frac{-1}{1 + j\omega K R_2 C - \omega^2 R_2^2 C^2}$$

$$\omega_0 = \frac{1}{R_2 C}, \quad Q = \frac{1}{3} \left(1 + \frac{R_4}{R_3} \right), \quad H_{0LP} = -1$$

$$\begin{aligned} \textcircled{3} \quad V_i &= -K \frac{1}{s R_2 C} V_{HP} - \frac{1}{s^2 R_2^2 C^2} V_{HP} - V_{HP} \\ &= - \frac{1 + s K R_2 C + s^2 R_2^2 C^2}{s^2 R_2^2 C^2} V_{HP} \end{aligned}$$

$$H_{HP}(j\omega) = \frac{- \omega^2 R_2^2 C^2}{1 + j\omega K R_2 C - \omega^2 R_2^2 C^2}$$

$$\omega_0 = \frac{1}{R_2 C}, \quad Q = \frac{1}{3} \left(1 + \frac{R_4}{R_3} \right), \quad H_{0HP} = -1$$

④ BPF $\frac{1}{2}$ TH

$$f_0 = \frac{1}{2\pi R_2 C} = 10^4 \Rightarrow R_2 C = 1.592 \times 10^{-5}$$

$$Q = \frac{f_0}{BW} = 100 = \frac{1}{3} \left(1 + \frac{R_4}{R_3} \right) \Rightarrow \frac{R_4}{R_3} = 299$$

$$C = 10 \text{ nF}, \quad R_2 = 1.592 \text{ k}\Omega, \quad R_3 = 1 \text{ k}\Omega$$

$$R_4 = 299 \text{ k}\Omega, \quad R_1 = 10 \text{ k}\Omega$$