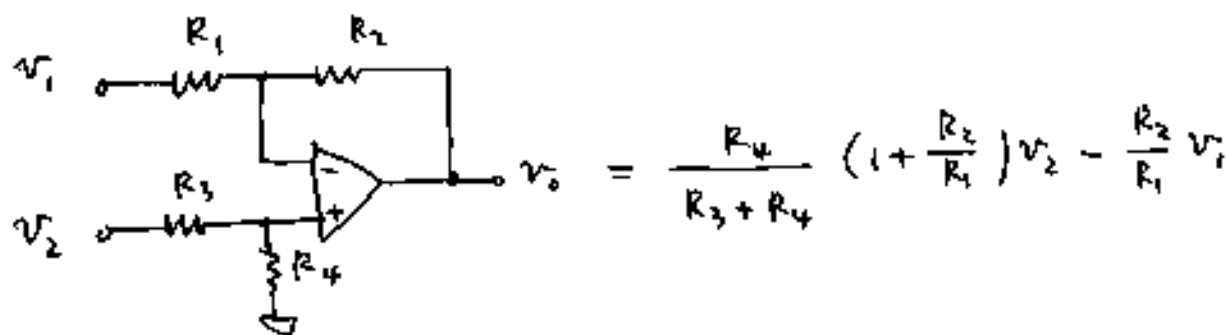


2001년 1학기 계측회로 II  
중간고사 해답

(1) (a) 차동 증폭기 이쁘른

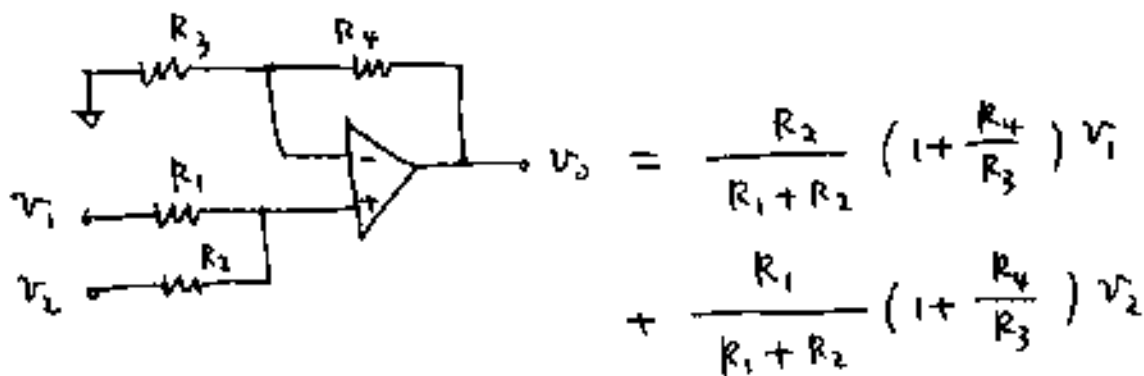


$$v_0 = \frac{R_4}{R_3 + R_4} \left(1 + \frac{R_2}{R_1}\right) v_2 - \frac{R_2}{R_1} v_1$$

$\frac{R_2}{R_1} = 5$  이니까  $R_2 = 5 \text{ k}\Omega$ ,  $R_1 = 1 \text{ k}\Omega$

$\frac{R_4}{R_3 + R_4} \times 6 = 3$  이니까  $R_3 = R_4 = 1 \text{ k}\Omega$

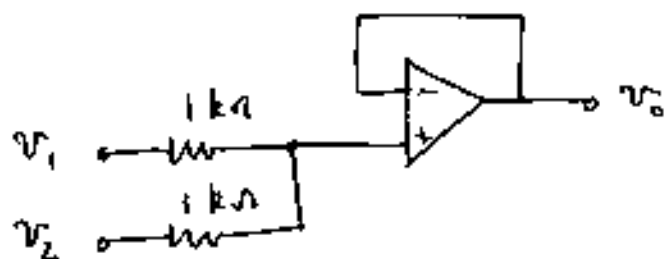
(b) 비 반전 Adder 이쁘른



$$v_0 = \frac{R_2}{R_1 + R_2} \left(1 + \frac{R_4}{R_3}\right) v_1 + \frac{R_1}{R_1 + R_2} \left(1 + \frac{R_4}{R_3}\right) v_2$$

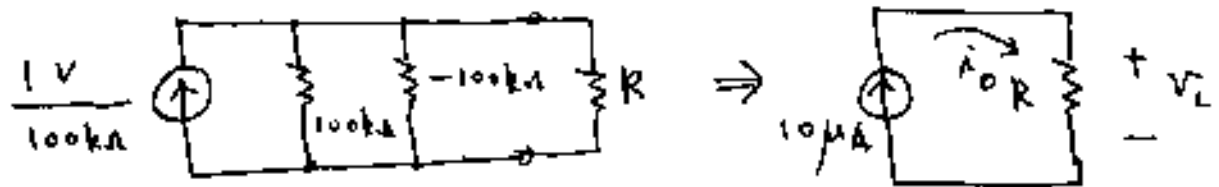
따라서  $R_1 = R_2 = 1 \text{ k}\Omega$ ,  $R_4 = 0$ ,  $R_3 = \infty$

이니까,



(2)

(a) 등가 회로를 그리면,



$$\therefore i_0 = 10 \mu A$$

(b) 전압 증폭기의 출력 전압을  $v_0$  라 하면,

$$v_0 = \left(1 + \frac{100}{100}\right) v_L = 2 v_L$$

$$\text{따라서 } |v_L| \leq \frac{10}{2} V \approx -5 \leq v_L \leq 5 V$$

(c)  $v_L = R \times i_0 = R \times 10^{-5} V$ ,  $|v_L| \leq 5 V$

$R = 500 k\Omega$  일 때  $v_L = 5 V$  이고,

$R > 500 k\Omega$  이면  $v_L = 5 V$  일.



즉,  $R \leq 500 k\Omega$  일 때  $10 \mu A$ 의 전류가 흐른다.

(d) 전류원의 등가 회로는



$$R_0 = \frac{100 k\Omega}{\Sigma}$$

$$\Sigma = 4 p = 4 \times 0.01 = 0.04 \text{ mS} \quad R_0 = \frac{100}{0.04} = 2.5 M\Omega$$

부하 전류의 최대 오차는  $R = 0.5 M\Omega$  일 때 일.

$$\frac{z}{7}, \quad i_o = \frac{2.5}{2.5 + 0.5} \times 10 = 8.33 \mu A$$

$$\% \text{ CM Error} = \frac{10 - 8.33}{10} \times 100 = 16.7 \%$$

(e)  $\% \text{ CM Error} = 5\%$   $\therefore i_o = 9.5 \mu A$

$$\frac{R_o}{R_o + 0.5} \times 10 = 9.5 \text{ uA} \quad R_o = 9.5 \text{ M}\Omega$$

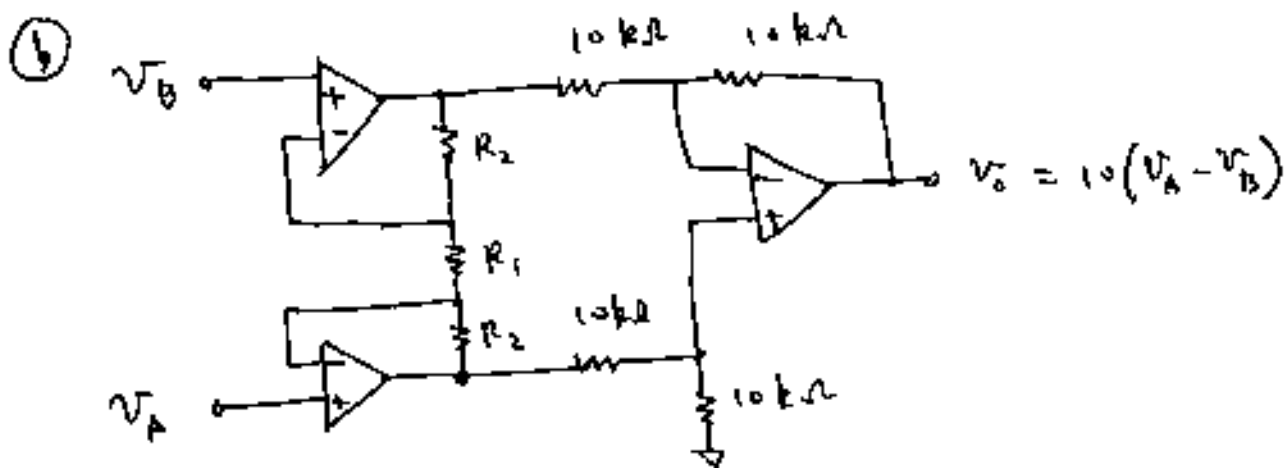
$$\frac{0.1 \text{ M}\Omega}{\epsilon} = 9.5 \text{ M}\Omega \text{ uA} \quad \epsilon = 0.0105$$

$$\rho = \frac{\epsilon}{4} = 0.002625 \quad \therefore 0.2\% \text{ 저항}$$

(3)

(a)  $v_{cm} = \frac{1}{2} (v_A + v_B) = 0.1 \sin(2\pi \times 60t) \text{ V}$

$$v_{dm} = v_A - v_B = 0.1 \sin(2\pi t) \text{ V}$$



$$1 + 2 \frac{R_2}{R_1} = 10 \text{ uA} \quad R_2 = 4.5 \text{ k}\Omega, \quad R_1 = 1 \text{ k}\Omega$$

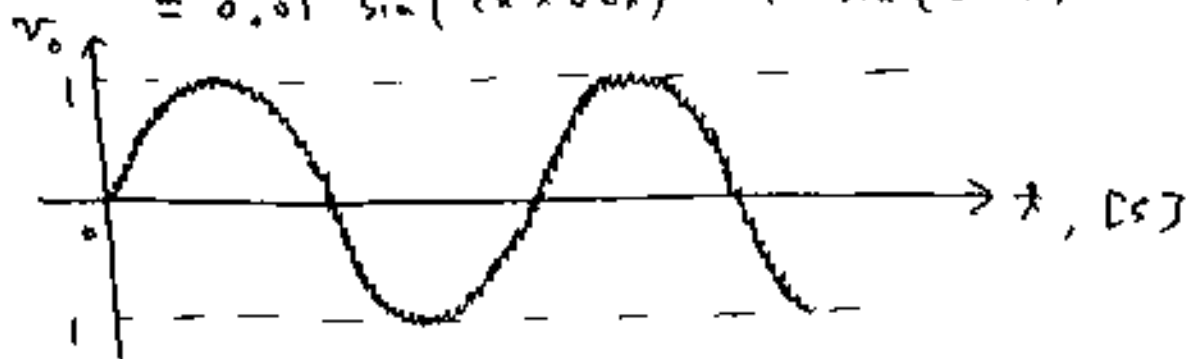
(c)  $CMRR = 20 \log \frac{A_{dm}}{A_{cm}} = 20 \log \frac{10}{A_{cm}} = 40$

$$\frac{10}{A_{cm}} = 100 \quad \therefore A_{cm} = 0.1$$

$$v_{o,cm} = A_{cm} v_{cm} = 0.01 \sin(2\pi \times 60t) \text{ V}$$

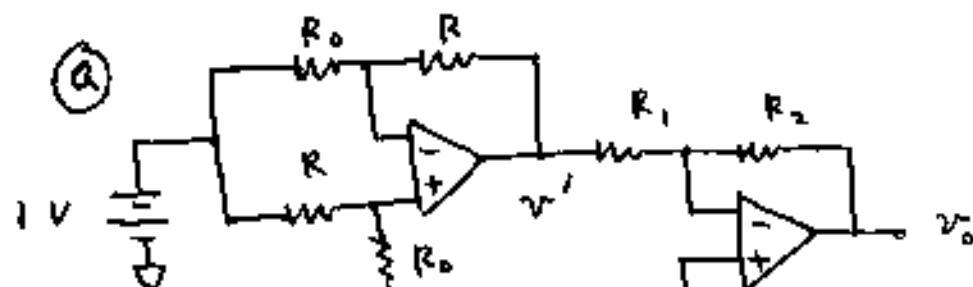
$$\textcircled{d} v_o = v_{o,cm} + v_{o,dm} = A_{cm} v_{cm} + A_{dm} v_{dm}$$

$$= 0.01 \sin(2\pi \times 60t) + \sin(2\pi t) \quad \text{V}$$



(4)  $\frac{1}{3} \text{ V}$  2-28 Hz  $\frac{1}{2} \text{ V}$   $\frac{1}{2} \text{ V}$

(5)  $R = R_0(1 + \delta) \Omega$ ,  $\delta = 0.001 \text{ F}$ ,  $F: 0 \sim 100 \text{ N}$



$$v' = \left\{ \frac{R_0}{R + R_0} \left( 1 + \frac{R}{R_0} \right) - \frac{R}{R_0} \right\} \times 1 \quad \text{V}$$

$$= 1 - \frac{R}{R_0} = 1 - (1 + \delta) = -\delta \quad \text{V}$$

$$v_o = -\frac{R_2}{R_1} v' = \frac{R_2}{R_1} \delta \quad \text{V}$$

$\textcircled{b}$   $F: 0 \sim 100 \text{ N}$  이 때  $\delta \in 0 \sim 0.1$

$$\delta = 0.1 \text{ 이 때, } v_o = \frac{R_2}{R_1} \times 0.1 = 10 \text{ V 이 때}$$

$$\frac{R_2}{R_1} = 100 \Rightarrow R_2 = 100 \text{ k}\Omega, R_1 = 1 \text{ k}\Omega$$

$\textcircled{c}$   $v_o = 100 \delta = 100 \times 0.001 \text{ F} = 0.1 \text{ F V}$

$$\Delta F = 1 \text{ N} \Rightarrow \Delta v_o = 0.1 \text{ V} \Rightarrow \frac{\Delta v_o}{\Delta F} = 0.1 \text{ V/N}$$

$$\Delta F = 0.1 \text{ N} \Rightarrow \Delta v_o = 0.01 \text{ V} = 10 \text{ mV}$$

$$\text{이 때, } \frac{\Delta v_o}{\Delta F} < 10 \text{ mV}$$