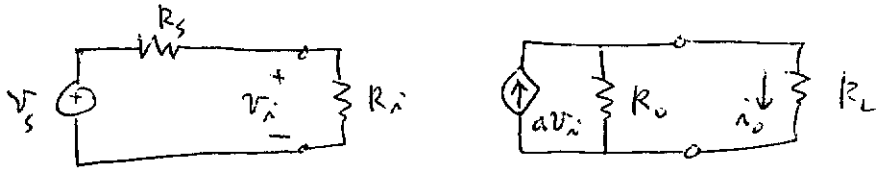
1장 연습문제 해답

1.2

(a) Transconductance Amp

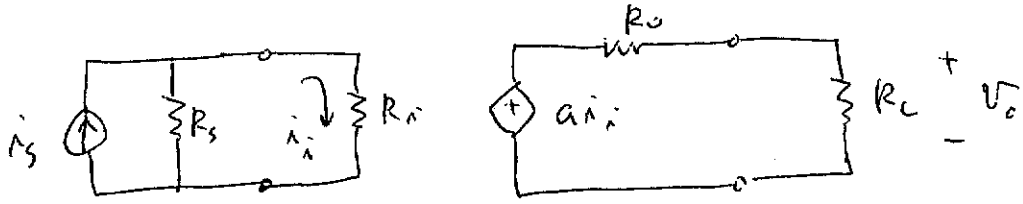


$$i_o = \frac{R_o}{R_o + R_L} a V_i$$

$$= \frac{R_o}{R_o + R_L} \times a \times \frac{R_i}{R_s + R_i} v_s$$

$$\therefore A = \frac{i_o}{v_s} = \frac{R_o}{R_o + R_L} a \frac{R_i}{R_s + R_i}$$

(b) Transresistance Amp.



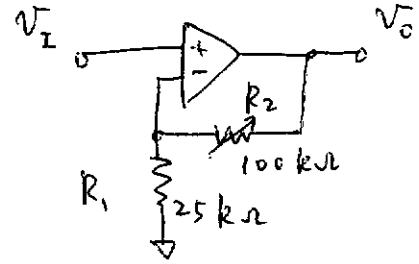
$$v_o = \frac{R_L}{R_o + R_L} a i_i$$

$$= \frac{R_L}{R_o + R_L} a \frac{R_s}{R_s + R_i} i_s$$

$$\therefore A = \frac{v_o}{i_s} = \frac{R_L}{R_o + R_L} a \frac{R_s}{R_s + R_i}$$

1.8

(a)

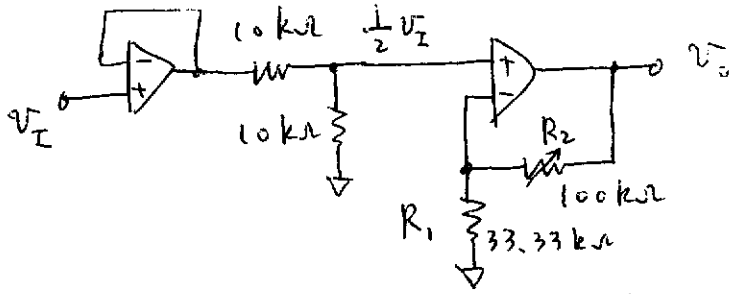


$R_2 = 0 \Rightarrow A = 1 + \frac{R_2}{R_1} = 1$

$R_2 = 100\,k\Omega \Rightarrow A = 1 + \frac{100}{R_1} = 5$

$\therefore R_1 = 25\,k\Omega$

(b)



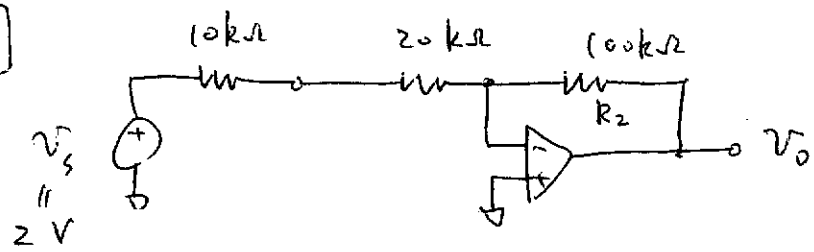
$$R_2 = 0 \Rightarrow A = \frac{1}{2}\left(1 + \frac{R_2}{R_1}\right) = 0.5$$

$$R_2 = 100\,k\Omega \Rightarrow A = \frac{1}{2}\left(1 + \frac{100}{R_1}\right) = 2$$

$$\therefore R_1 = 33.33\,k\Omega$$

1.12

(a)



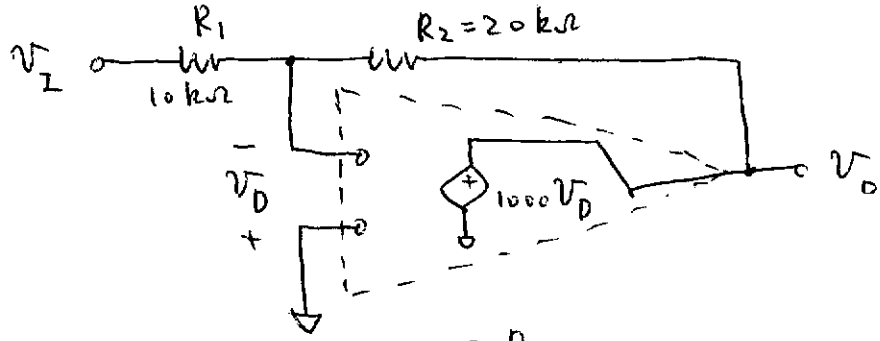
$$V_o = -\frac{100}{30} \times 2 = -6.66\ V$$

$$\therefore |V_o| < 10\ V$$

(b) 이득이 −5 이내로 하려면,

$$\frac{R_2}{30} = 5 \qquad \therefore R_2 = 150\,k\Omega$$

1.14



$$A = \frac{V_o}{V_I} = \frac{-aR_2}{(1+a)R_1 + R_2} = -1.994$$

$(a = 1000)$

$$v_I = 5 \sin(2\pi \times 1000 t) \quad V$$

$$v_o = -9.97 \sin(2\pi \times 1000 t) \quad V$$

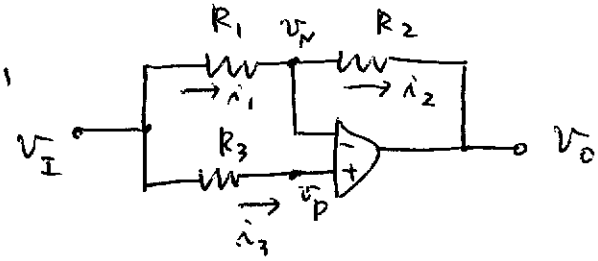
$$v_D = \frac{v_o}{1000} = -9.97 \sin(2\pi \times 1000 t) \quad mV$$

$$v_D = v_p - v_N = 0 - v_N$$

$$\therefore v_N = -v_D = 9.97 \sin(2\pi \times 1000 t) \quad mV$$

1.21

(a) ① S/W open 시

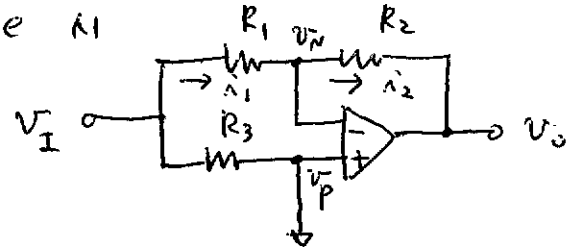


$$i_3 = 0 \Rightarrow v_p = v_I = v_N$$

$$i_1 = \frac{v_I - v_N}{R_1} = 0 \Rightarrow i_2 = i_1 = 0$$

$$\therefore v_o = v_N = v_I \Rightarrow A = 1$$

② S/W close 시

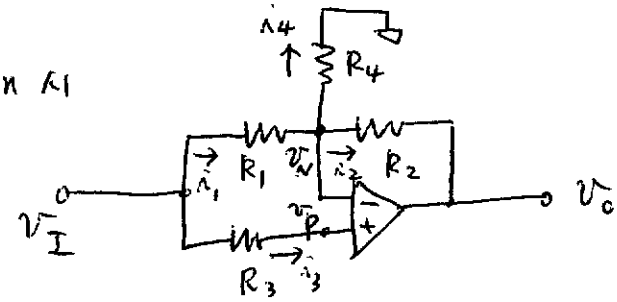


$$v_p = 0 = v_N \Rightarrow i_1 = \frac{v_I}{R_1} = i_2$$

$$v_o = -R_2 i_2 = -\frac{R_2}{R_1} v_I$$

$$\therefore A = -\frac{R_2}{R_1}$$

(b) ① S/W open 시



$i_3 = 0 \Rightarrow v_p = v_I = v_N$

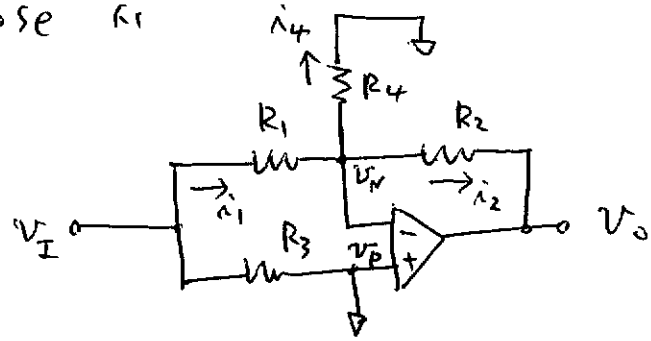
$i_1 = \frac{v_I - v_N}{R_1} = 0$, $i_4 = \frac{v_N}{R_4} = \frac{v_I}{R_4}$

$i_1 = i_2 + i_4 \Rightarrow i_2 = -i_4 = -\frac{v_I}{R_4} = \frac{v_N - v_o}{R_2} = \frac{v_I - v_o}{R_2}$

$\therefore v_o = v_I + \frac{R_2}{R_4} v_I = \left(1 + \frac{R_2}{R_4}\right) v_I$

$\therefore A = 1 + \frac{R_2}{R_4}$

(ii) S/W close 시



$v_p = 0 = v_N$

$i_1 = \frac{v_I}{R_1}$, $i_2 = -\frac{v_o}{R_2}$, $i_4 = \frac{0}{R_4} = 0$

$i_1 = i_2 + i_4 = i_2$ 이므로

$\frac{v_I}{R_1} = -\frac{v_o}{R_2} \Rightarrow v_o = -\frac{R_2}{R_1} v_I$

$\therefore A = -\frac{R_2}{R_1}$

(c) $R_2 = R_4 = 20\,k\Omega$, $R_1 = 10\,k\Omega$

1-31

(i) $v_1 = v_3 = v_5 = 0$ 이므로

$\frac{v_2 - v_p}{R} + \frac{v_4 - v_p}{R} + \frac{v_6 - v_p}{R} = \frac{v_p}{R} \Rightarrow v_p = \frac{1}{4}(v_2 + v_4 + v_6)$

$v_{o1} = v_p \times \left(1 + \frac{R}{\frac{R}{3}}\right) = v_2 + v_4 + v_6$

(11) $v_2 = v_4 = v_6 = 0$ 이므로

$$v_p = v_N = 0$$

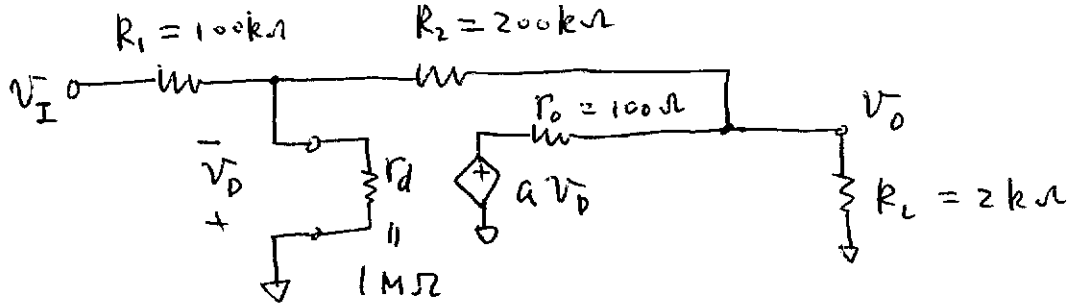
$$\frac{v_1}{R} + \frac{v_3}{R} + \frac{v_5}{R} = -\frac{v_{o2}}{R}$$

$$v_{o2} = -v_1 - v_3 - v_5$$

$$\therefore v_o = v_{o1} + v_{o2} = v_2 + v_4 + v_6 - v_1 - v_3 - v_5$$

(v_6 제외 모두 입력)

1-52



$$A = -\frac{aR_2 - r_o}{(1+a)R_1 + (R_2 + r_o)(1 + R_1/r_d)}$$

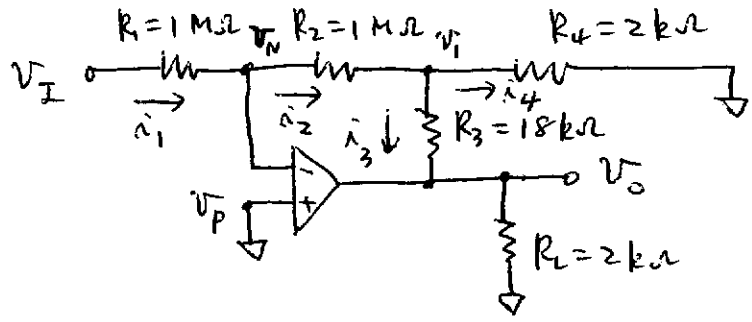
$$= -\frac{200a - 0.1}{(1+a)\times 100 + (200 + 0.1)(1 + 100/1000)}$$

$$= -\frac{200a - 0.1}{100a + 320.11}$$

(a) $$2 - \frac{200a - 0.1}{100a + 320.11} = 0.02 \Rightarrow a \doteq 633.92$$

(b) $$2 - \frac{200a - 0.1}{100a + 320.11} = 0.00002 \Rightarrow a \doteq 320,156.8$$

1-66



$v_p = v_N = 0$

$$i_1 = \frac{v_I}{R_1} = i_2 = \frac{-v_1}{R_2} \Rightarrow v_1 = -\frac{R_2}{R_1} v_I$$

$$i_3 = \frac{v_1 - v_o}{R_3}, \quad i_4 = \frac{v_1}{R_4}$$

$i_2 = i_3 + i_4$ 이므로

$$\frac{-v_1}{R_2} = \frac{v_1 - v_o}{R_3} + \frac{v_1}{R_4} \Rightarrow \frac{v_o}{R_3} = \left(\frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right) v_1$$

$$\therefore v_o = \left(\frac{R_3}{R_2} + \frac{R_3}{R_3} + \frac{R_3}{R_4}\right) v_1 = \left(1 + \frac{R_3}{R_2} + \frac{R_3}{R_4}\right) v_1$$

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

$$= -10.018\, v_I$$

(a) $V_{im} = 0.5\,V \Rightarrow V_{om} = 5.009\,V$

(포화되지 않음)

(b) $V_{im} = 2\,V \Rightarrow V_{om} = 20.036\,V$

(포화됨 → clipping)

$v_1 = -\frac{R_2}{R_1} v_I = -v_I$ 이므로

$V_{1m} = V_{im} \Rightarrow$ (a) 와 (b) 모두 적용됨