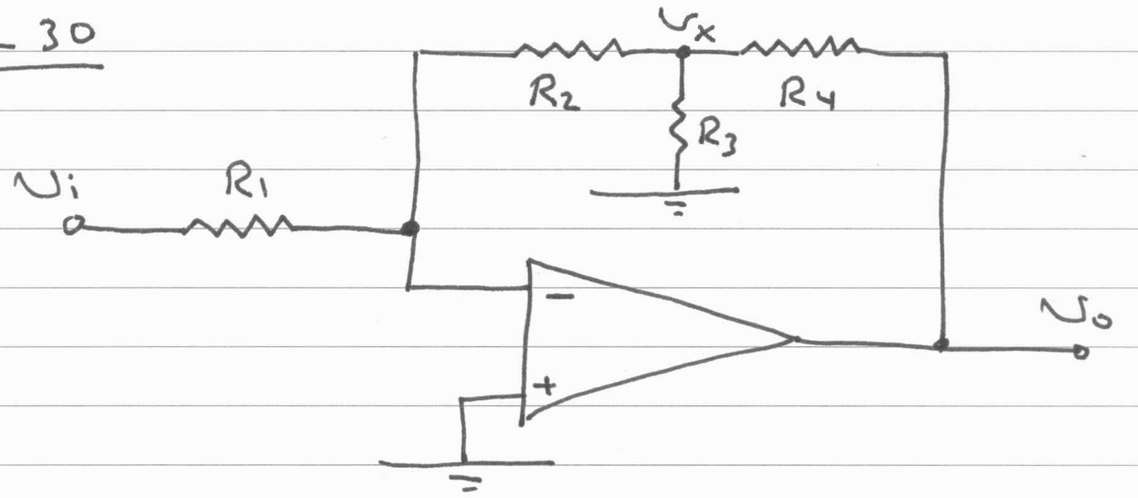
Ch 2 Homework Solutions

2-30



$$\frac{v_i - v(-)}{R_1} + \frac{v_x - v(-)}{R_2} = 0$$

$$v(-) = v(+) = 0$$

$$\therefore \frac{v_x}{v_i} = -\frac{R_2}{R_1}$$

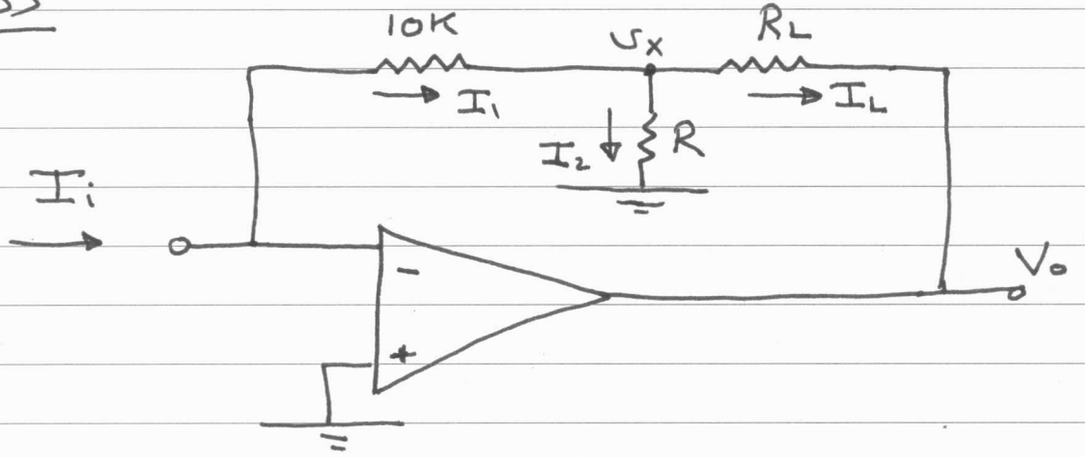
$$v_x = \frac{R_2 \| R_3}{R_2 \| R_3 + R_4} v_o$$

$$\frac{v_o}{v_x} = 1 + \frac{R_4}{R_3} + \frac{R_4}{R_2}$$

$$\therefore \frac{v_o}{v_i} = \frac{v_o}{v_x} \cdot \frac{v_x}{v_i}$$

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

2.33



a) $V_x = -10K\, I_1$

$V_x = -10K\, I_i$

$I_2 = \frac{V_x}{R} = \frac{-10K\, I_i}{R}$

$I_L = I_1 - I_2$

$I_L = I_i - \frac{-10K\, I_i}{R}$

$\therefore I_L = \left(1 + \frac{10K}{R}\right) I_i$

But $I_L = 20 I_i$

$\therefore \quad 1 + \frac{10K}{R} = 20$

$\therefore R = 0.53K$

b) $V_o = -R_L I_L - 10K\, I_i$

$V_o = -R_L (20 I_i) - 10K\, I_i$

$V_o = -(1K)(20 I_i) - 10K\, I_i$

$V_o = -(30K)\, I_i$

$V_o = -30K\, I_i$

$V_{o,max} = 12\ V$

$V_{o,min} = -12\ V$

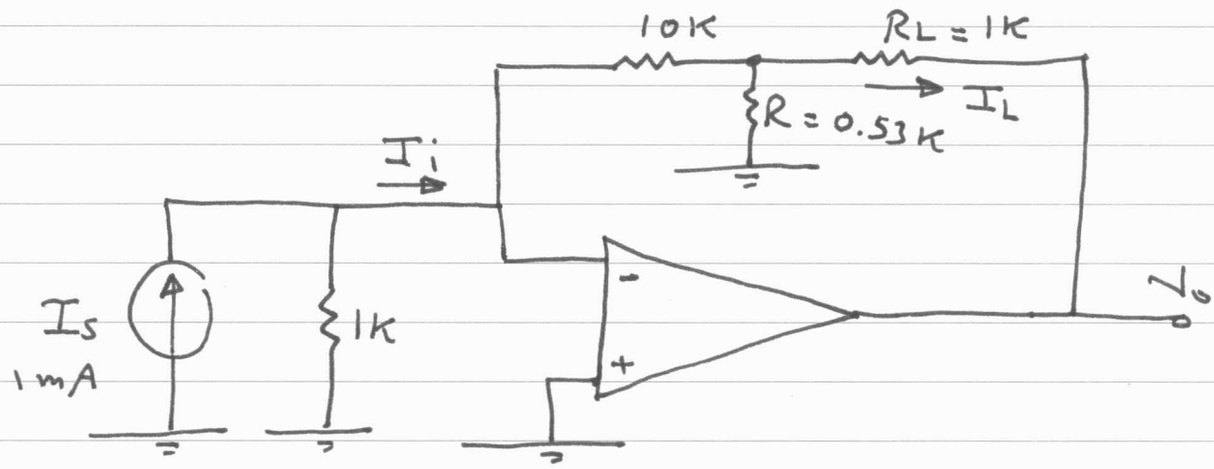
$\therefore$ when $V_o = 12\ V$; $I_i = -0.4\ mA$

$\therefore$ when $V_o = -12\ V$; $I_i = +0.4\ mA$

$\therefore \quad 0.4\ mA \geq I_i \geq -0.4\ mA$

c) $Z_i = \frac{V_i}{I_i} = \frac{-V_d}{I_i} = \frac{0}{I_i} = 0\ \Omega$

d)



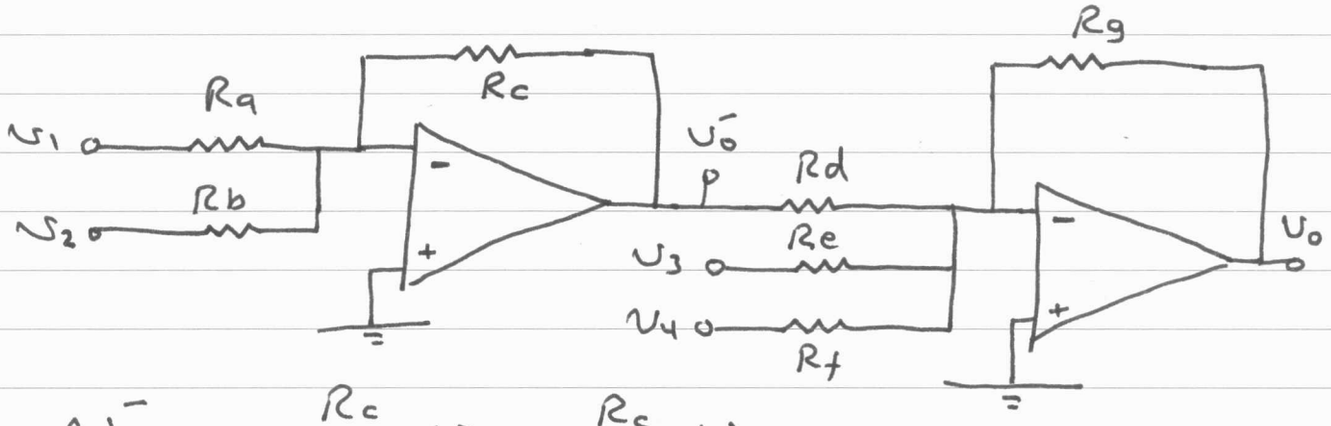
$I_L = 20\, I_i$

$I_i = I_s$

$\therefore I_L = 20\, I_s = 20\ mA$

2.41

$$V_o = V_1 + 2V_2 - 3V_3 - 4V_4$$



$$V_o' = -\frac{R_c}{R_a} V_1 - \frac{R_c}{R_b} V_2$$

$$V_o' = -V_1 - 2V_2$$

$$\therefore \frac{R_c}{R_a} = 1 \quad ; \quad \frac{R_c}{R_b} = 2$$

let $R_c = 20K$

$$\therefore R_a = 20K \text{ , and } R_b = 10K$$

$$V_o = -\frac{R_g}{R_d} V_o' - \frac{R_g}{R_e} V_3 - \frac{R_g}{R_f} V_4$$

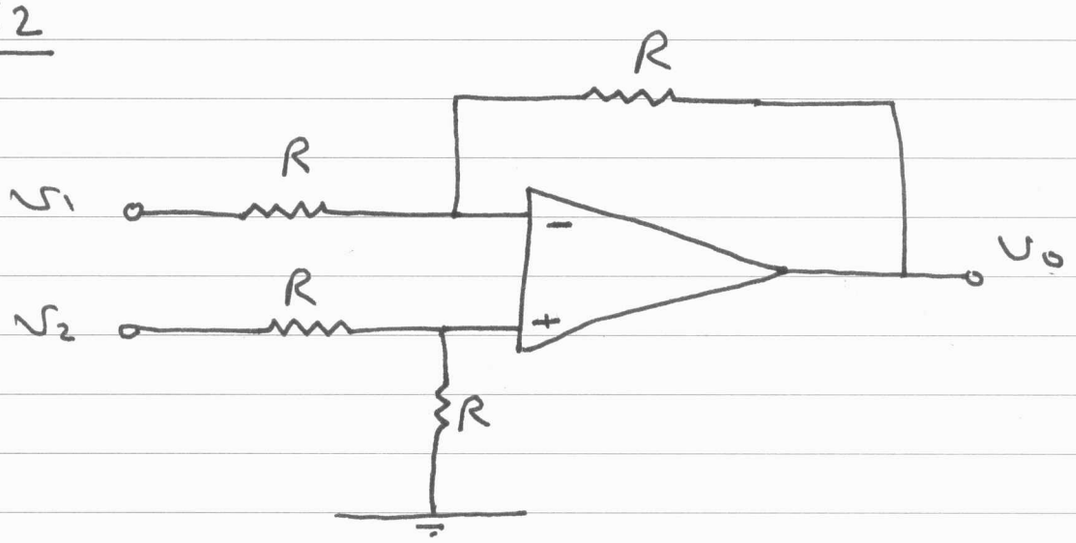
$$V_o = -V_o' - 3V_3 - 4V_4$$

$$\therefore \frac{R_g}{R_d} = 1 \quad ; \quad \frac{R_g}{R_e} = 3 \quad ; \quad \frac{R_g}{R_f} = 4$$

let $R_g = 60K$

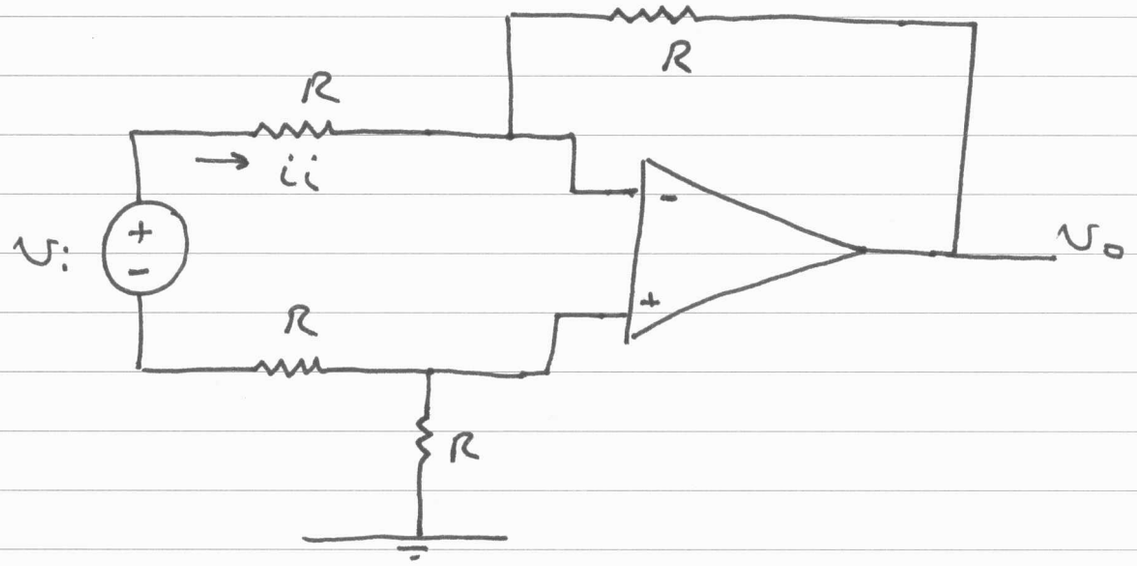
$$\therefore R_d = 60K \; ; \; R_e = 20K, \text{ and } R_f = 15K$$

2.62



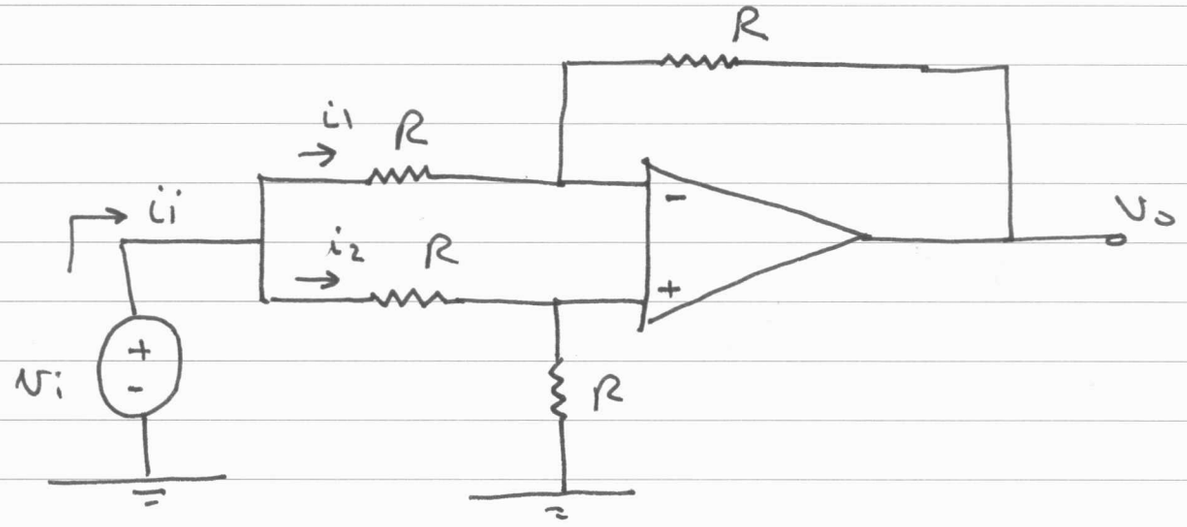
$Z_1 = R$; seen by v_1 only

$Z_2 = 2R$; seen by v_2 only



$$-v_i + Ri_i + Ri_i = 0$$

$$\therefore \frac{v_i}{i_i} = 2R$$



$$i_i = i_1 + i_2$$

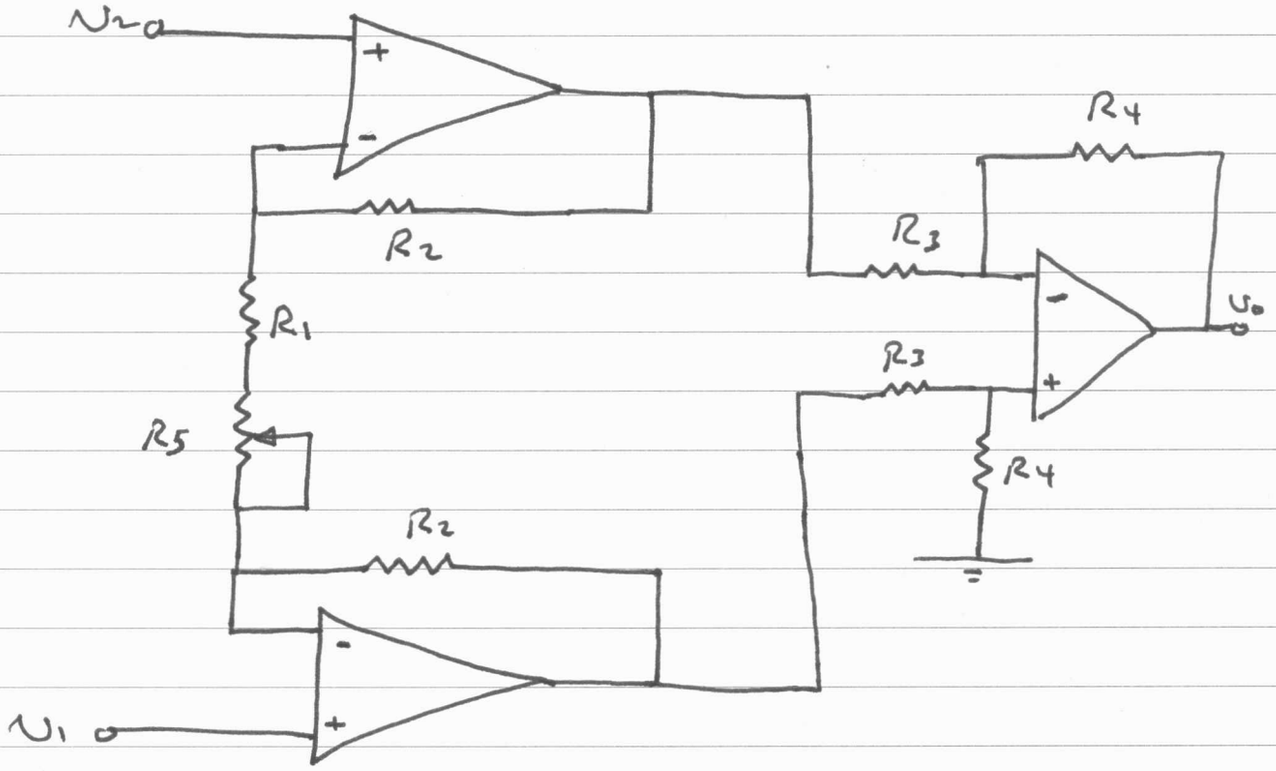
$$i_2 = \frac{V(+)}{R} = \frac{V_i}{2R}$$

$$i_1 = \frac{V_i - V(-)}{R} = \frac{V_i - V(+)}{R} = \frac{V_i}{2R}$$

$$\therefore i_i = i_1 + i_2 = \frac{V_i}{R}$$

$$\therefore \frac{V_i}{i_i} = R$$

2.76



The gain of the second stage = 0.5

$$\therefore \quad \frac{R_4}{R_3} = 0.5$$

let $R_4 = 10K$; $\therefore R_3 = 20K$

$R_5(min) = 0$; $R_5(max) = 100K$

$$Ad = \frac{v_o}{v_d} = \frac{R_4}{R_3}\left(1 + \frac{2R_2}{R_1 + R_5}\right)$$

$$\therefore \quad 1 + \frac{2R_2}{R_1 + R_5} = \begin{cases} 2 & \text{for } R_5 = 100K \\ 200 & \text{for } R_5 = 0 \end{cases}$$

$$\therefore \quad 1 + \frac{2R_2}{R_1 + R_5} = 2$$

$$1 + \frac{2R_2}{R_1 + 100K} = 2$$

$$\therefore \quad 2R_2 = R_1 + 100K \qquad \text{—— (1)}$$

$$\therefore \quad 1 + \frac{2R_2}{R_1} = 200$$

$$\therefore \quad R_2 = 99.5\, R_1 \qquad \text{—— (2)}$$

Solving (1) and (2)

$R_1 = 0.505K$

$R_2 = 50.25K$