EE 315 Module 2A Practical Problem Solutions

(1)

$R_i = 80\,k\Omega$

$$G = \frac{200}{80} = 2.5\ V/V$$

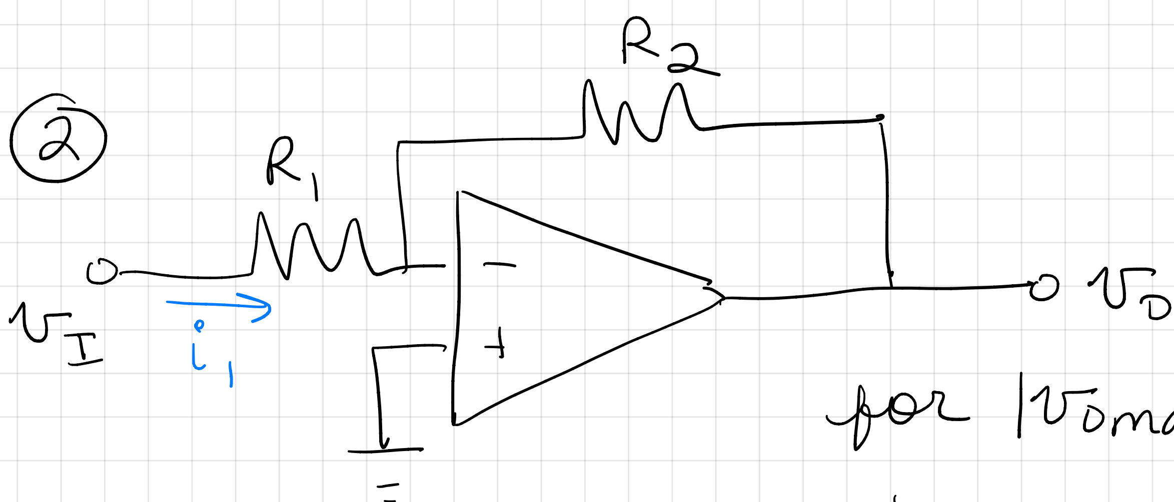
$R_i = 15\,k\Omega$

$$G = \frac{30}{15} = 2\ V/V$$

$R_i = 40\,k\Omega$

$$G = \frac{90}{40} = 2.25\ V/V$$

(2)



for $|v_{O\max}| = 10V$

$$|v_{I\max}| = \frac{10}{5} = 2V$$

$i_{max} = 50 \times 10^{-6} A$

$-10V \leq v_O \leq 10V$

$$G = -5\frac{V}{V}$$

$$i_{max} = \frac{v_I}{R_1} = \frac{2}{R_1} = 50 \times 10^{-6}$$

$$\boxed{R_1 = 40\,k\Omega}$$

$$-5 = \frac{-R_2}{R_1}$$

$$R_2 = 5R_1$$

$$\boxed{R_2 = 200\,k\Omega}$$

check R_2 current

$$\left| \frac{0 - v_{omax}}{200 \times 10^3} \right| \le 50\,\mu A$$

$$\left| \frac{-10}{200 \times 10^3} \right| = 50\,\mu A$$

okay!

③ for standard inverting configuration

$$G = \frac{-R_2}{R_1}$$

$$R_i = R_1$$

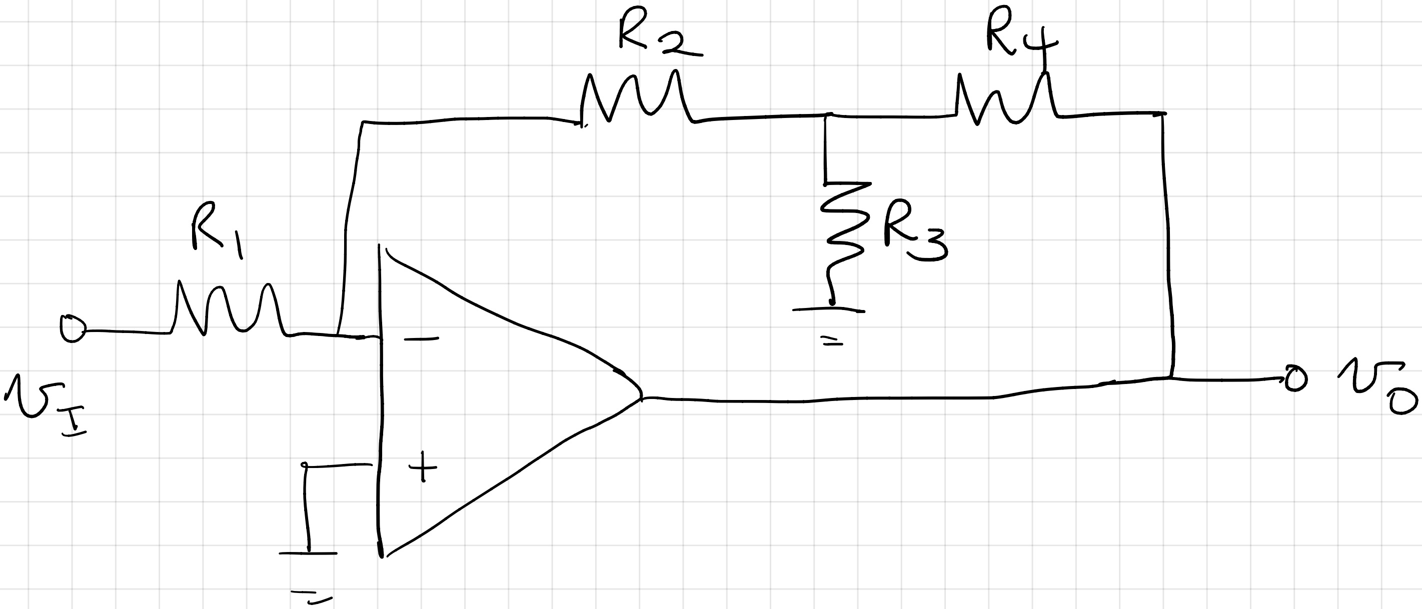
$$\boxed{R_i = 10\,k\Omega}$$

max $R = 100\,k\Omega$

$$G = -1000\ V/V$$

$$1000 = \frac{\cancel{R_2}\ 100\,k\Omega}{R_1}$$

$$\boxed{\begin{aligned} R_1 &= 10\,k\Omega \\ R_2 &= 100\,k\Omega \end{aligned}}$$



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

let $R_1 = R_2 = R_4 = 100\ k\Omega$

$$\frac{v_O}{v_I} = -\frac{\cancel{100}^{1}}{\cancel{100}}\left(\frac{\cancel{100}^{1}}{\cancel{100}} + \frac{100\times10^3}{R_3} + 1\right) = -1000$$

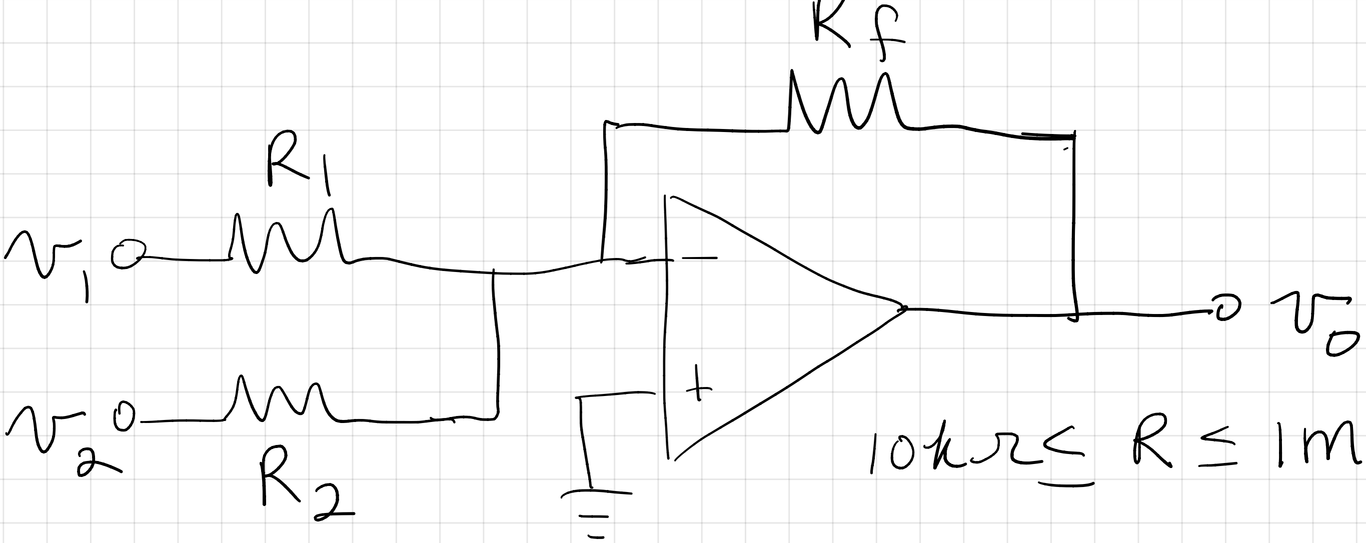
$$2 + \frac{100\times10^3}{R_3} = 1000$$

$$\boxed{R_i = 100k\Omega}$$

$$\frac{100\times10^3}{R_3} = 998$$

$$\boxed{R_3 = 100.20\ \Omega}$$

4 $\boxed{v_0 = -2v_1 - 8v_2}$



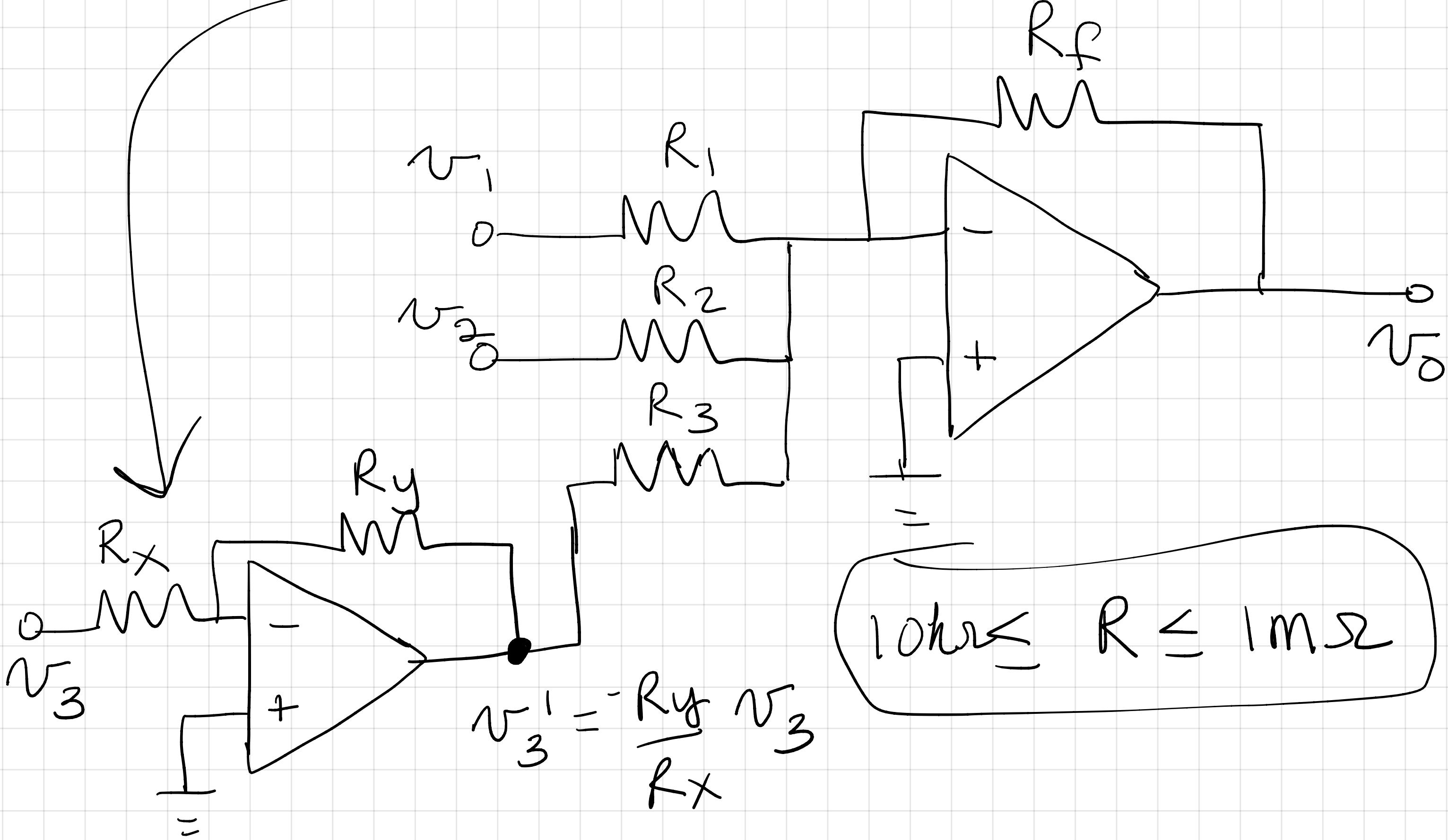
$10k\Omega \leq R \leq 1M\Omega$

$$v_0 = -\frac{R_f}{R_1} v_1 - \frac{R_f}{R_2} v_2$$

$$\frac{R_f}{R_1} = 2 \qquad \frac{R_f}{R_2} = 8$$

let
$$\boxed{\begin{aligned} R_f &= 400\,k\Omega \\ R_1 &= \frac{R_f}{2} = 200\,k\Omega \\ R_2 &= \frac{R_f}{8} = 50\,k\Omega \end{aligned}}$$

④ b. $v_o = -12v_1 - 3v_2 + 2v_3$



$v_3' = -\frac{R_y}{R_x} v_3$

$10k\Omega \leq R \leq 1M\Omega$

$$v_o = -\frac{R_f}{R_1} v_1 - \frac{R_f}{R_2} v_2 - \frac{R_f}{R_3} v_3'$$

$$v_o = -\frac{R_f}{R_1} v_1 - \frac{R_f}{R_2} v_2 + \frac{R_f}{R_3} \cdot \frac{R_y}{R_x} v_3$$

$\frac{R_f}{R_1} = 12 \qquad \frac{R_f}{R_2} = 3 \qquad \frac{R_y}{R_x} \frac{R_f}{R_3} = 2$

let $R_f = 600\,k\Omega$

$R_y = 10\,k\Omega$

$R_x = 10\,k\Omega$

$R_3 = \frac{R_y}{R_x} \cdot \frac{R_f}{2}$

$\boxed{R_3 = 300\,k\Omega}$

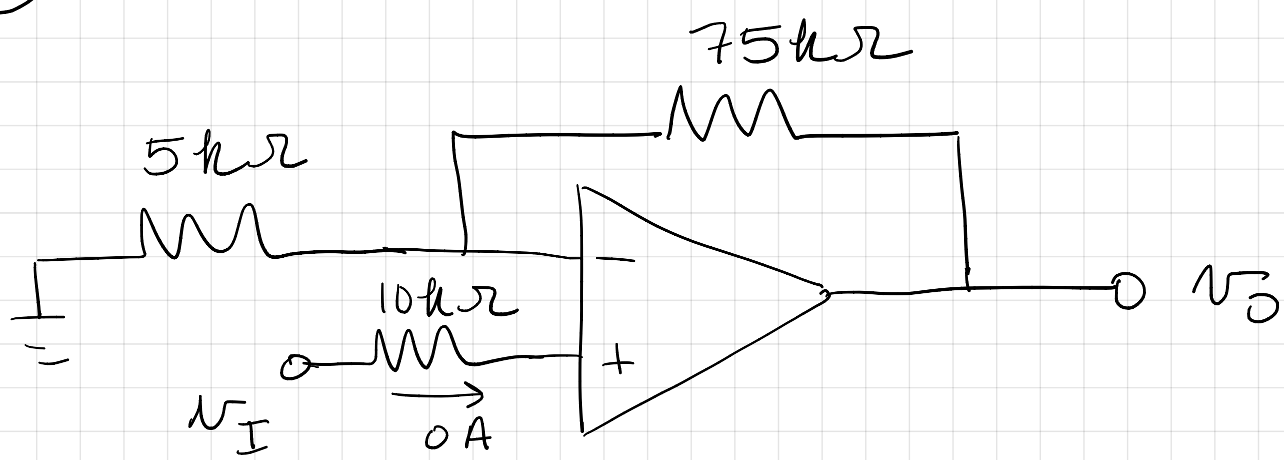
$R_1 = \frac{R_f}{12}$

$\boxed{R_1 = 50\,k\Omega}$

$R_2 = \frac{R_f}{3}$

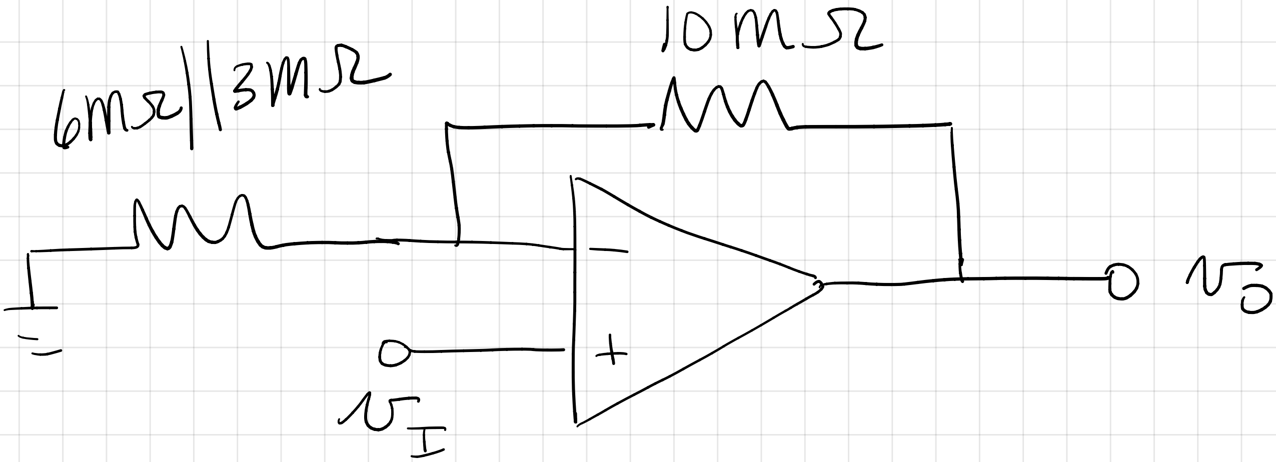
$\boxed{R_2 = 200\,k\Omega}$

5



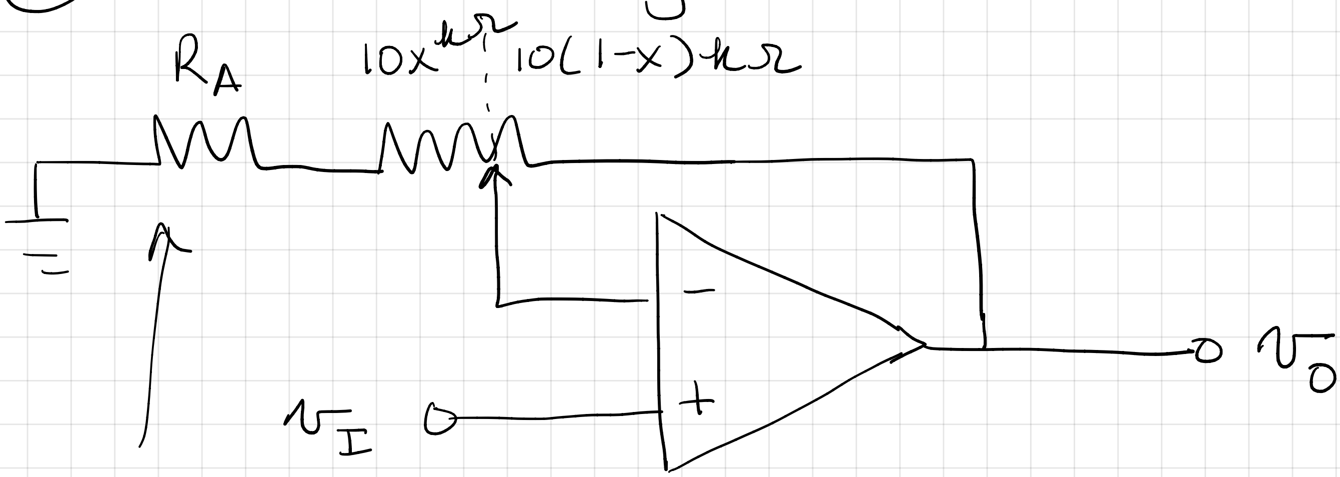
$R_i = \infty$

$G = 1 + \frac{75}{5} = 16\ V/V$



$R_i = \infty$ $G = 1 + \frac{10}{2} = 6\ \frac{V}{V}$

(6) (to control gain



add a fixed resistor that prevents the gain from going to infinity

when $x = 0$ (max gain)

$R_1 = R_A$

$R_2 = 10\text{k}\Omega$

$G = 11\ V/V$

$x = 1$ (min gain)

$R_2 = 0$

$R_1 = R_A + 10\text{k}\Omega$

$G = 1$

$$G = 1 + \frac{R_2}{R_1} = 11$$

$$\frac{R_2}{R_1} = 10$$

$$\frac{10k\Omega}{R_A} = 10$$

$$\boxed{R_A = 1k\Omega}$$

(7.) inverting amp

$$\left.\begin{aligned} R_2 &= 100k\Omega \\ R_1 &= 5k\Omega \end{aligned}\right\} \text{chose these at random}$$

ideal : $G = -\frac{R_2}{R_1} = -20V/V$

finite : $$G = \frac{-R_2/R_1}{1 + \frac{1}{A}\left(1 + \frac{R_2}{R_1}\right)}$$

A (V/V)	G (V/V)
100	-16.53
1,000	-19.59
10,000	-19.96
100,000	-19.996
1,000,000	-19.9996

looking at this range

A changes by a factor of 1000

G changes by a factor of 1.02

pretty stable yay!

Cont non-inverting

ideal $R_2 = 100k\Omega$, $R_1 = 5k\Omega$ } again chose random

$$\frac{v_O}{v_I} = 1 + \frac{R_2}{R_1} = 21\ V/V$$

non ideal $$G = \frac{1 + R_2/R_1}{1 + \frac{1 + R_2/R_1}{A}}$$

A (V/V)	G (V/V)
100	17.35
1,000	20.57
10,000	20.956
100,000	20.9956
1,000 000	20.9996

a

looking at this range

A changes by a factor of 1000

G changes by a factor of 1.02

pretty stable yay!