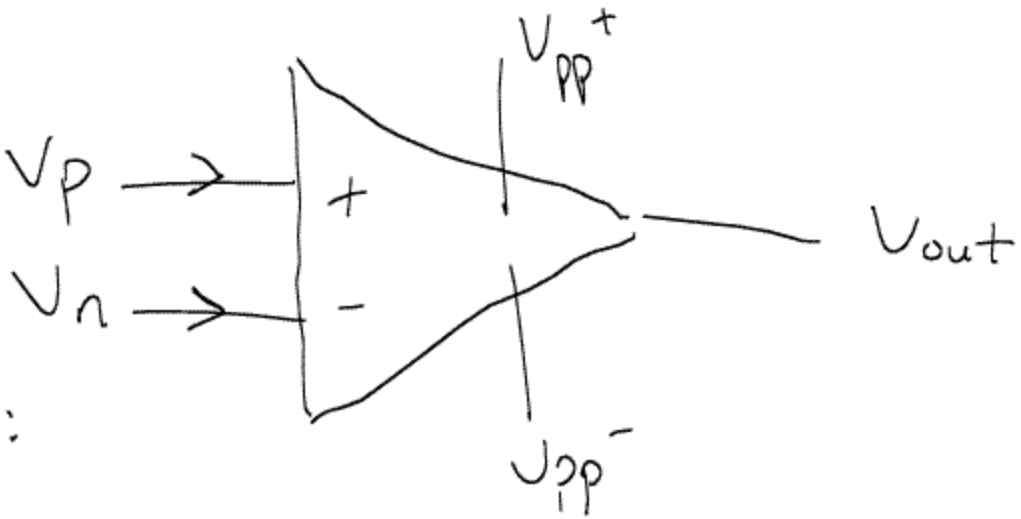
Lecture 18 03/17/05



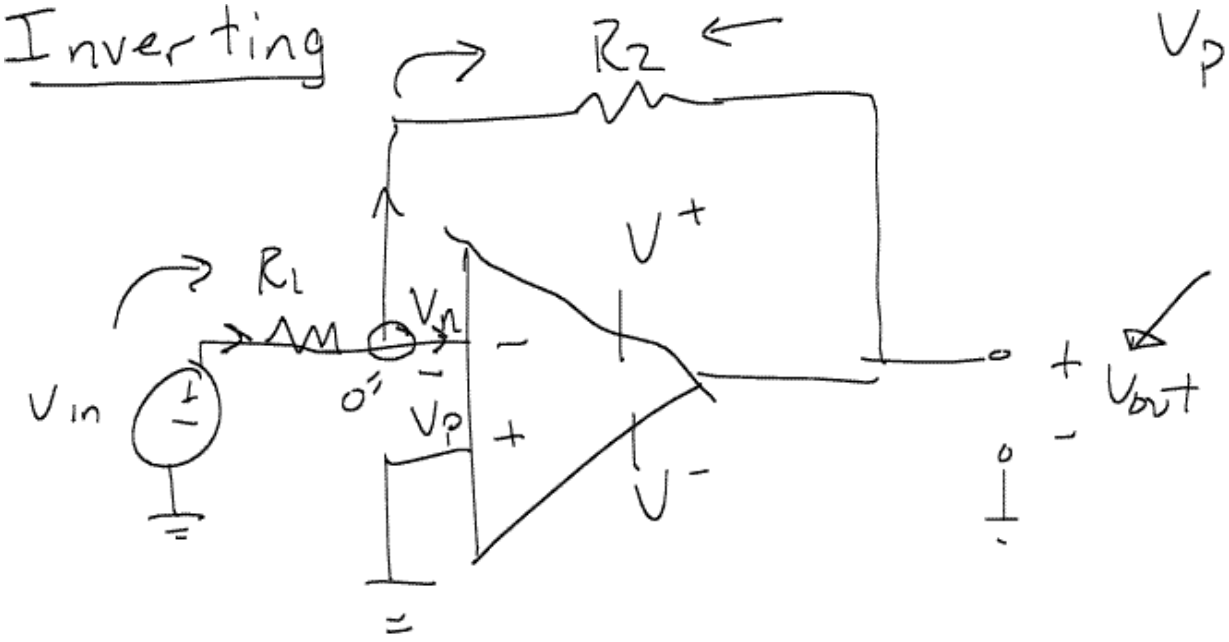
IDEAL:

$V_p = V_n$

$i_p = i_n = 0$

Inverting

$V_p = 0 = V_n$



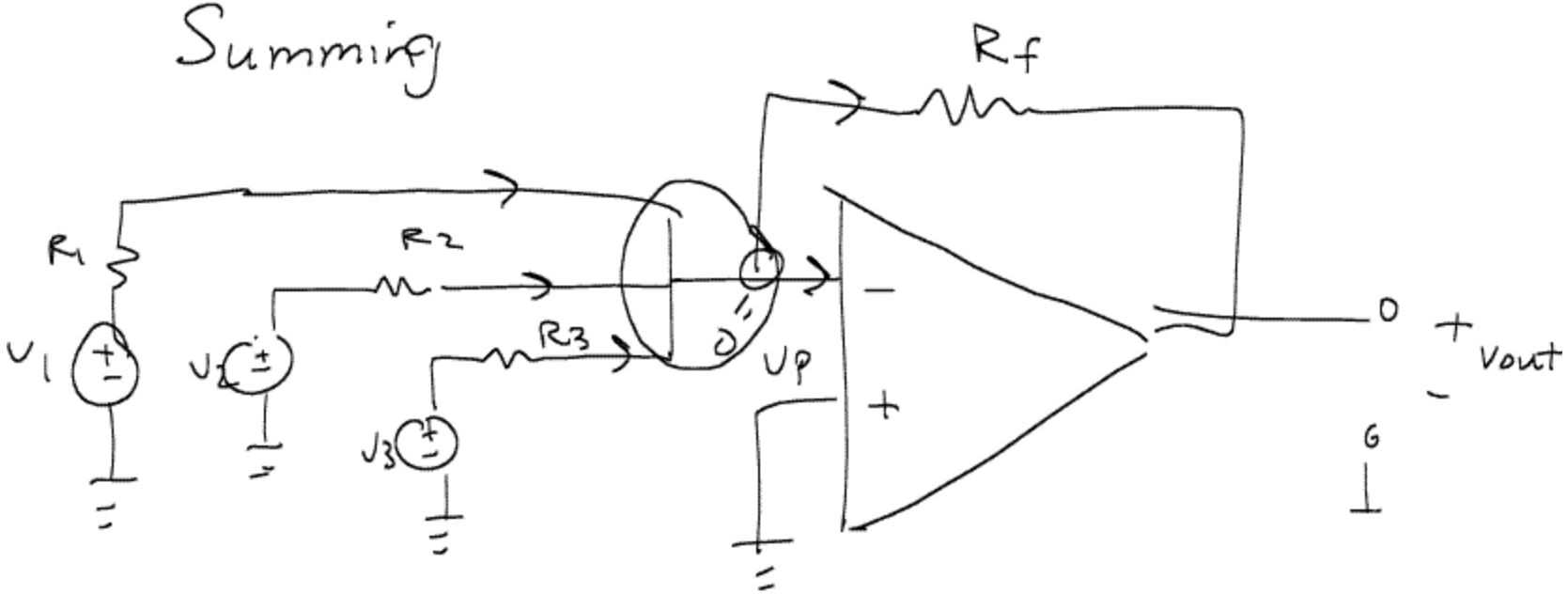
$$\frac{V_{in} - 0}{R_1} = \frac{0 - V_{out}}{R_2}$$

$$\boxed{\frac{V_{out}}{V_{in}} = -\frac{R_2}{R_1}}$$

V_{in} Connected to V_n → Inverting

V_{in} " " V_p → Non-inverting

Summing

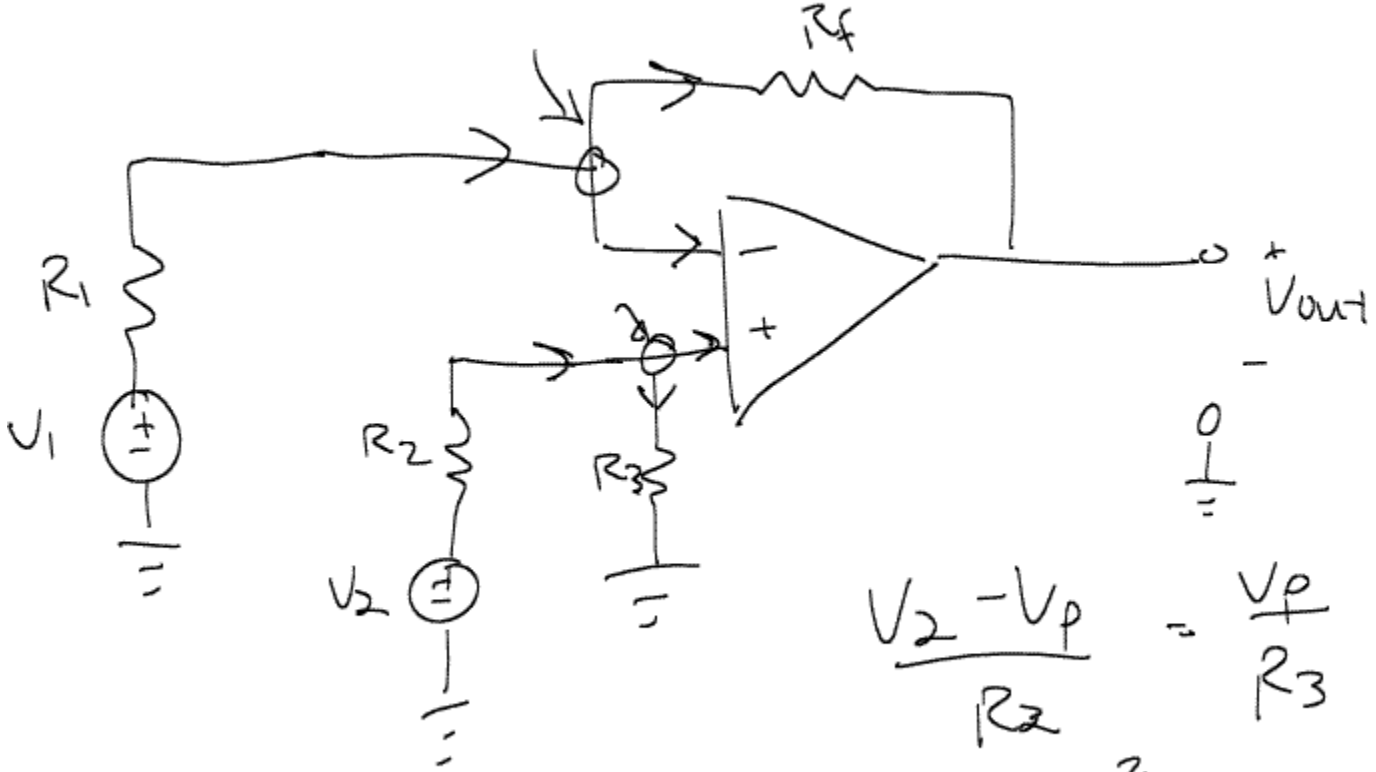


$$\frac{V_1 - 0}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} = \frac{-V_{out}}{R_f}$$

$$V_{out} = -R_f \left[\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \right]$$

Difference

$V_p = V_n$



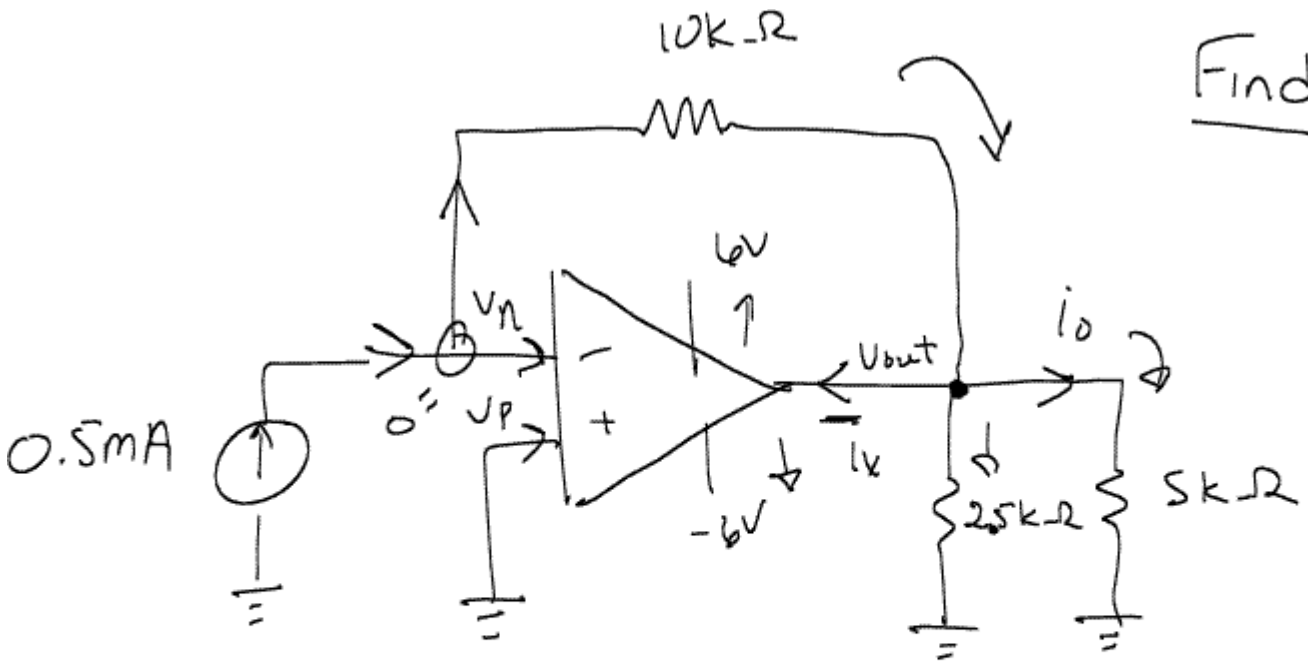
$$\frac{V_2 - V_p}{R_2} = \frac{V_p}{R_3}$$

$$V_p = \frac{R_3}{R_2 + R_3} V_2$$

$$\frac{V_1 - V_p}{R_1} = \frac{V_p - V_{out}}{R_f}$$

$$V_{out} = \frac{R_3(R_1 + R_f)}{R_1(R_2 + R_3)} V_2 - \frac{R_f}{R_1} V_1$$

Sample problem (not 5.3)

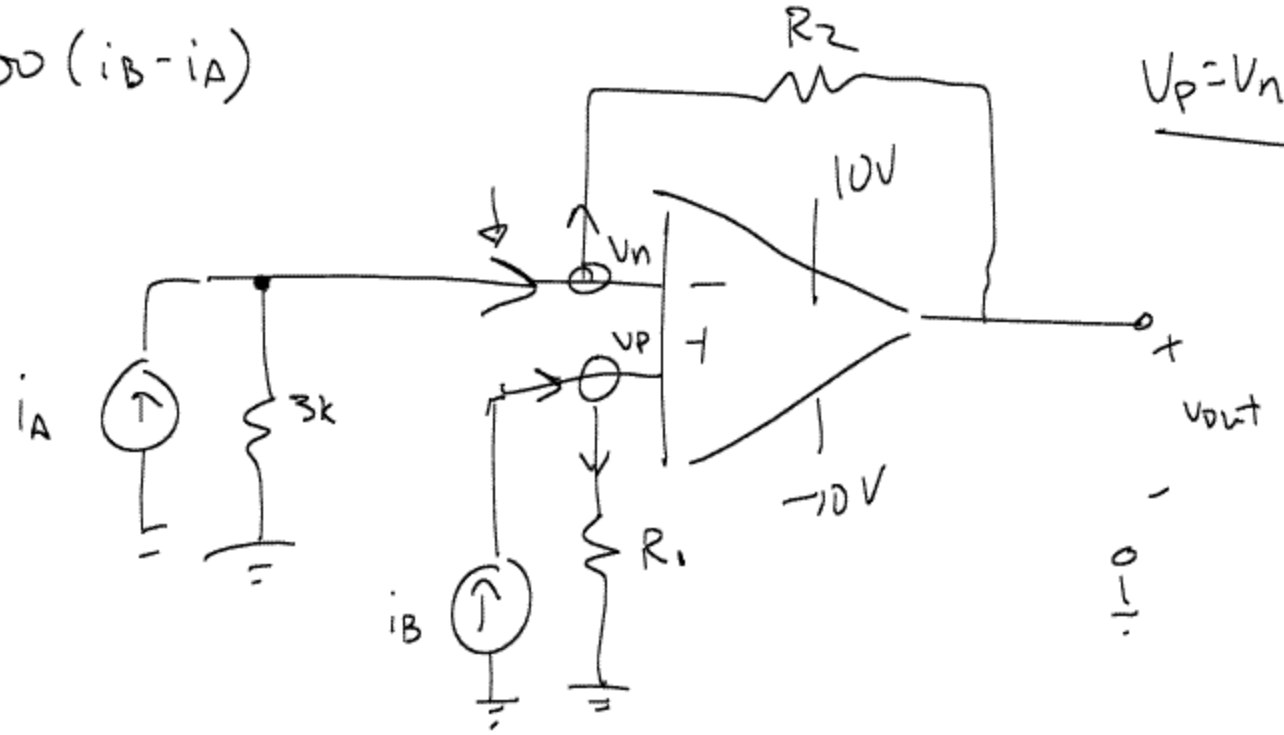


Nodal @ v_n : $0.5mA = \frac{0 - V_{out}}{10k}$ $\quad V_{out} = -5V$

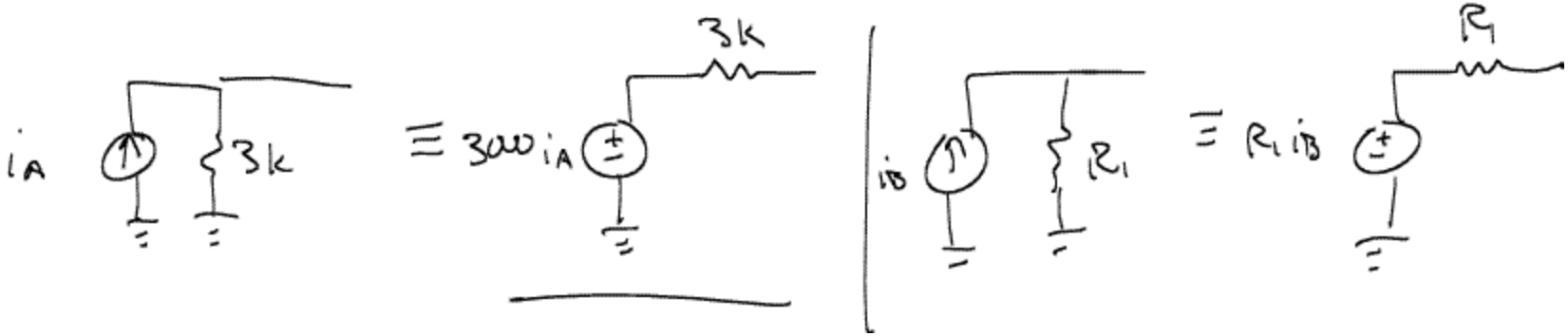
$i_o = \frac{V_{out} - 0}{5k} = -.001A = -1mA$

Ex. 2

$V_{out} = 2000\,(i_B - i_A)$



$V_P = V_n = R_1\, i_B$



$$\frac{3000\, i_A - R_1 i_B}{3000} = \frac{R_1 i_B - v_{out}}{R_2}$$

$$3000\, i_A R_2 - R_1 R_2 i_B = 3000 R_1 i_B - 3000\, v_{out}$$

$$v_{out} = \frac{3000 R_1 i_B - 3000 i_A R_2 + R_1 R_2 i_B}{3000}$$

$$v_{out} = \frac{(3000 R_1 + R_1 R_2) i_B - 3000 i_A R_2}{3000}$$

$$\boxed{v_{out} = 2000 (i_b - i_a)} \rightarrow \frac{3000 R_1 + R_1 R_2}{3000} = 2000$$

$$\frac{3000 R_2}{3000} = 2000$$