

$$A_{cl} = \frac{V_{out}}{V_{in}}$$

Non-inverting config

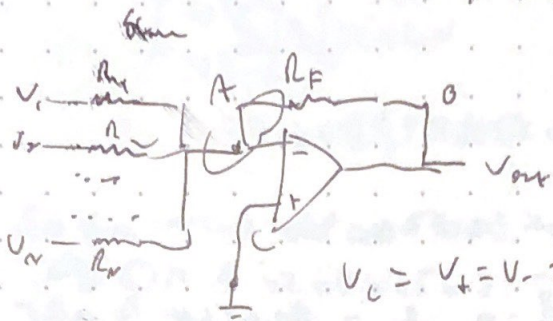
$$V_D = 0$$

KCL @ A

$$i_1 = i_2$$

$$\frac{V_D - V_A}{R_1} = \frac{V_A - V_C}{R_f} \rightarrow \frac{-V_A}{R_1} = \frac{V_A - V_C}{R_f}$$

$$V_f = V_- \quad V_D = V_A = V_{in}$$



$$V_{out} = -R_f \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \dots + \frac{V_n}{R_n} \right)$$

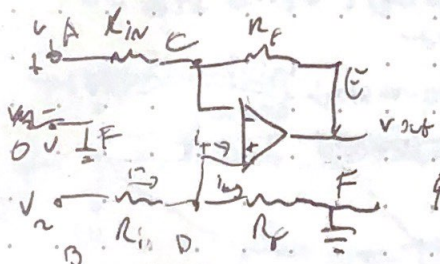
$$V_C = V_+ = V_- = 0 \text{ V}$$

KCL @ A: $i_1 + i_2 + \dots + i_n = i_f$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} + \dots + \frac{V_n}{R_n} = \frac{V_A - V_B}{R_f}$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} + \dots + \frac{V_n}{R_n} = -\frac{V_{out}}{R_f}$$

Diff. Op. Amp



$$V_C = 0 \text{ V}; V_A = V_1; V_B = V_2; V_D = V_+$$

KCL @ D

$$R_f V_f = \frac{R_f}{R_f + R_f} V_2$$

$$i_a = i_b + i_c$$

$$\frac{V_D - V_B}{R_1} = \frac{V_D}{R_f}$$

$$V_C = V_- = V_+ = \frac{R_f}{R_f + R_1} V_2$$

$$R_f V_B = (R_f + R_1) V_D$$

KCL @ C: $i_a = i_s$

$$\frac{V_A - V_C}{R_1} = \frac{V_C - V_C}{R_f} = \frac{V_C - V_{out}}{R_f}$$

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

$$\frac{R_f}{R_1} (V_A - V_C) + V_C = V_{out}$$

$$= -\frac{R_f}{R_1} V_1 + \frac{R_f + R_1}{R_1} \frac{R_f}{R_f + R_1} V_2$$

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

$$= \frac{R_f}{R_1} (V_2 - V_1)$$