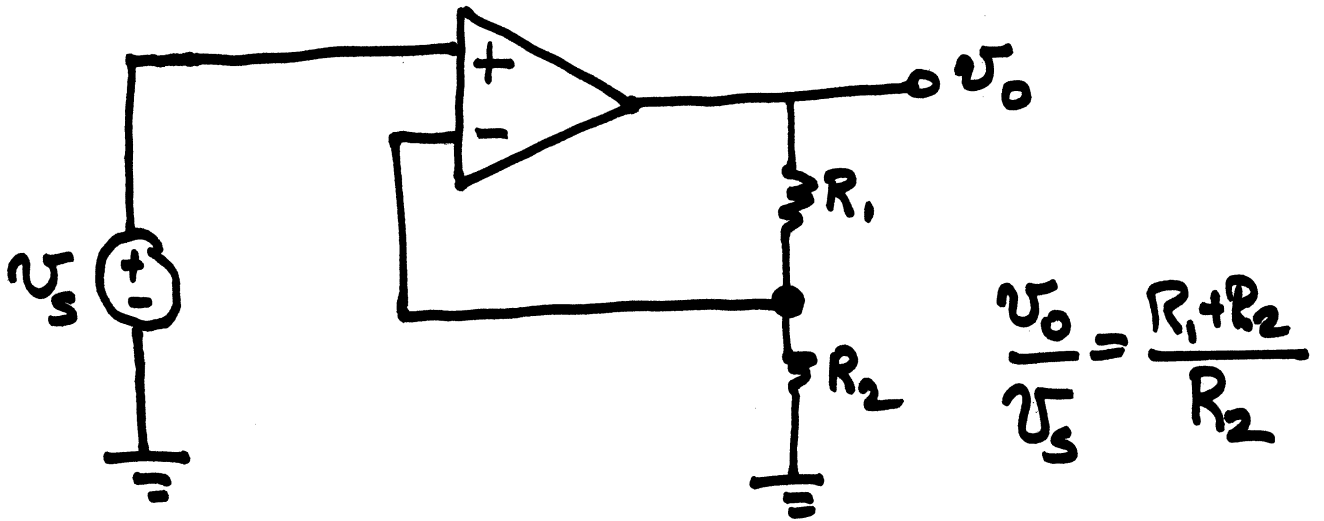
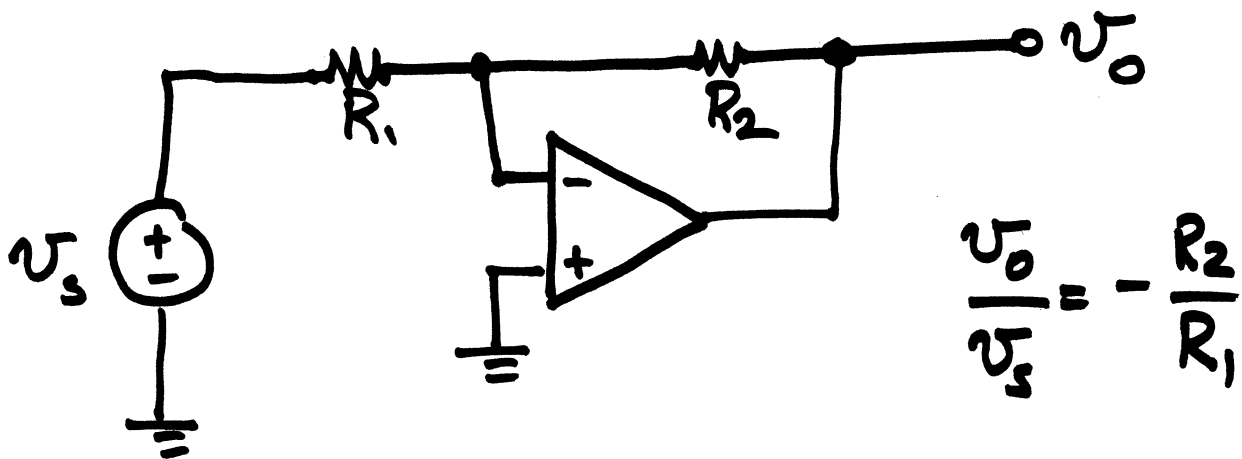


OP AMPS (short summary)

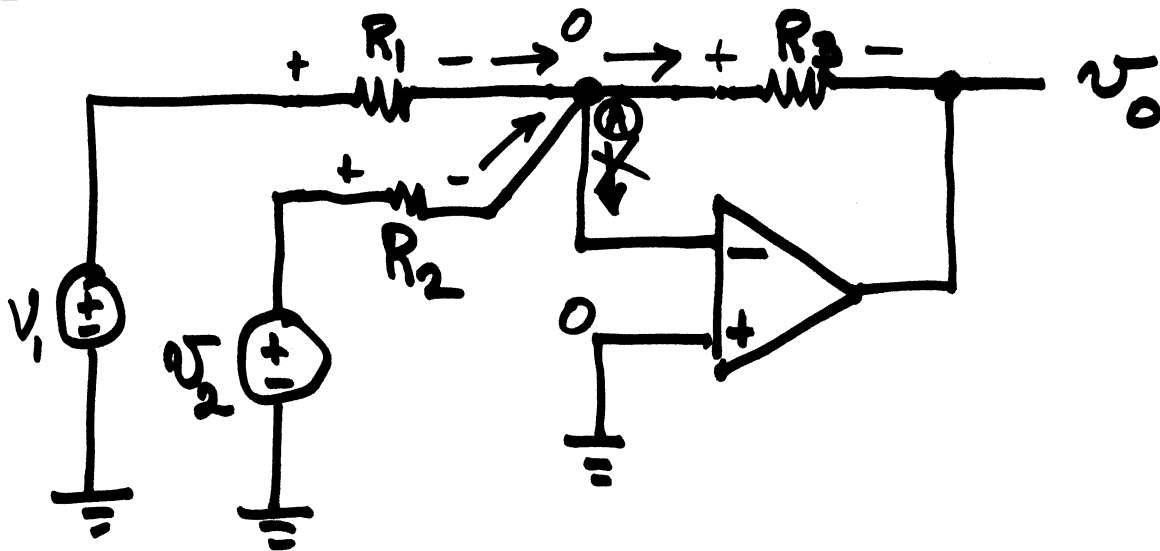
NON-INVERTING AMPLIFIER



INVERTING AMPLIFIER



THE SUMMING AMPLIFIER



$$\sum i = 0 @ A \quad + \frac{V_1 - 0}{R_1} + \frac{V_2 - 0}{R_2} - \frac{0 - V_0}{R_3} = 0$$

$$\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_0}{R_3} = 0$$

$$V_0 = -\frac{R_3}{R_1} V_1 - \frac{R_3}{R_2} V_2$$

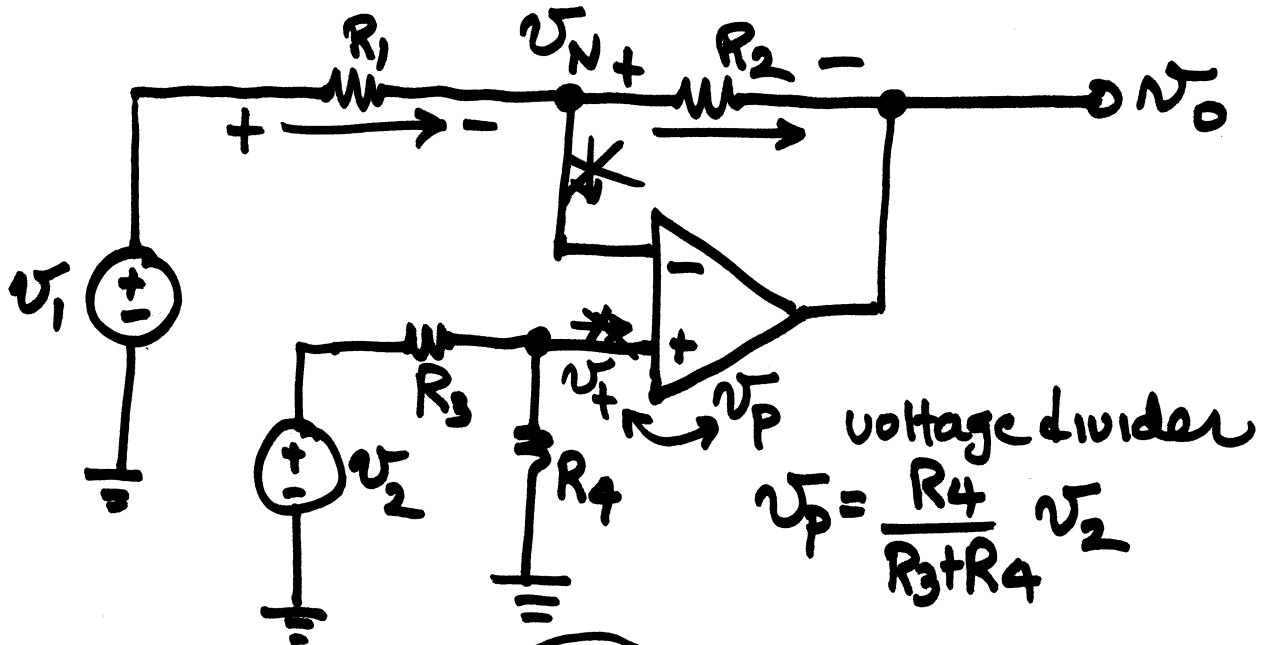
usually factor out -

$$V_0 = -\left(\frac{R_3}{R_1} V_1 + \frac{R_3}{R_2} V_2\right)$$

If $R_1 = R_2 = R$ then

$$V_0 = -\frac{R_3}{R} (V_1 + V_2)$$

THE DIFFERENTIAL AMPLIFIER



$$U_P = U_N = \frac{R_4}{R_3 + R_4} U_2$$

$$\text{KCL } \sum i = 0 \quad + \frac{U_1 - U_N}{R_1} - \frac{U_N - U_0}{R_2} = 0$$

$$\frac{U_1 - \frac{R_4}{R_3 + R_4} U_2}{R_1} = \frac{\frac{R_4}{R_3 + R_4} U_2 - U_0}{R_2}$$

$$\frac{R_2}{R_1} U_1 - \frac{R_4 R_2}{R_1 (R_3 + R_4)} U_2 = \frac{R_4}{R_3 + R_4} U_2 - U_0$$

$$U_0 = -\frac{R_2}{R_1} U_1 + \frac{R_4}{R_3 + R_4} U_2 + \frac{R_4}{R_3 + R_4} \frac{R_2}{R_1} U_2$$

$$U_0 = -\underbrace{\frac{R_2}{R_1}}_{K_1} U_1 + \underbrace{\frac{R_4}{R_3 + R_4} \left(1 + \frac{R_2}{R_1}\right)}_{K_2} U_2$$

$$U_0 = -K_1 U_1 + K_2 U_2$$