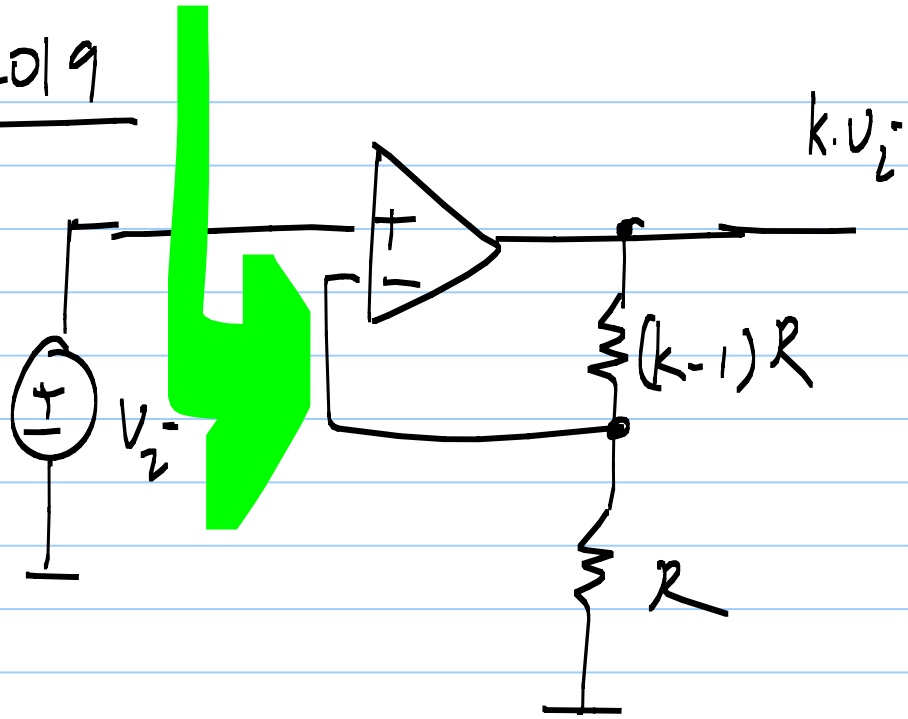
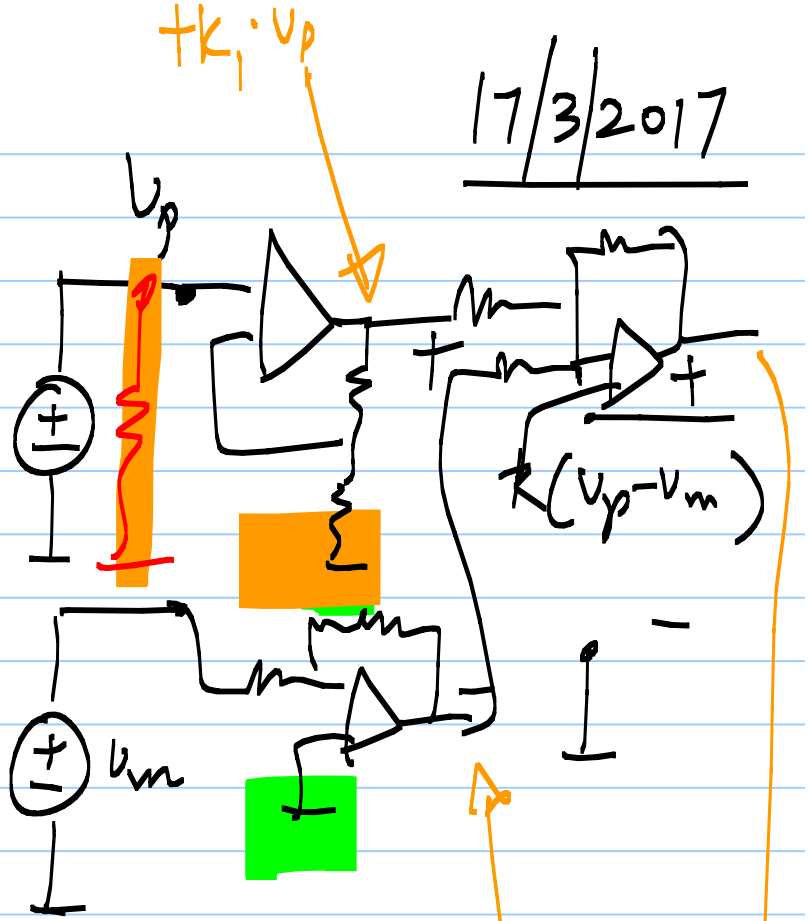
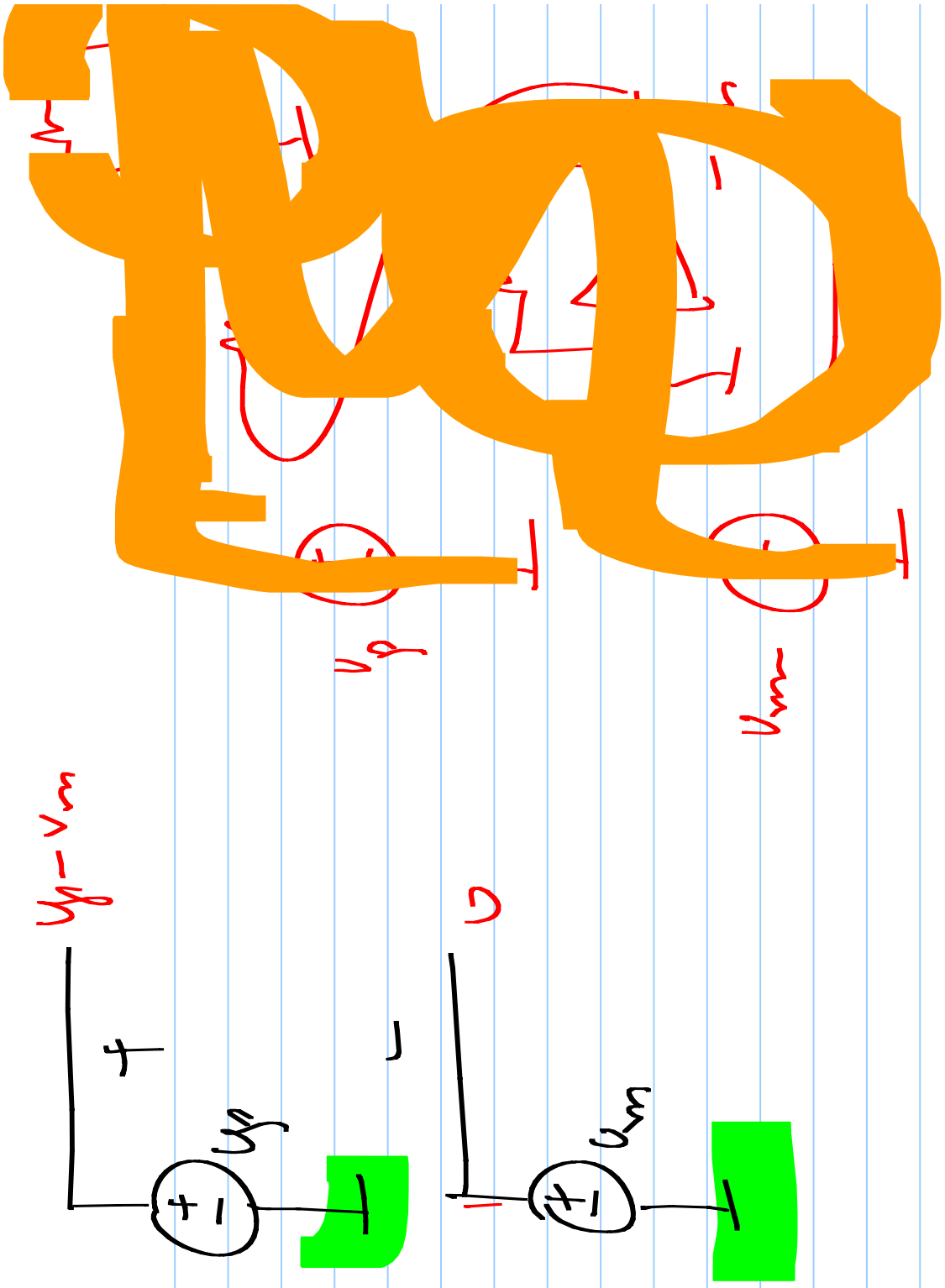
EE 2019

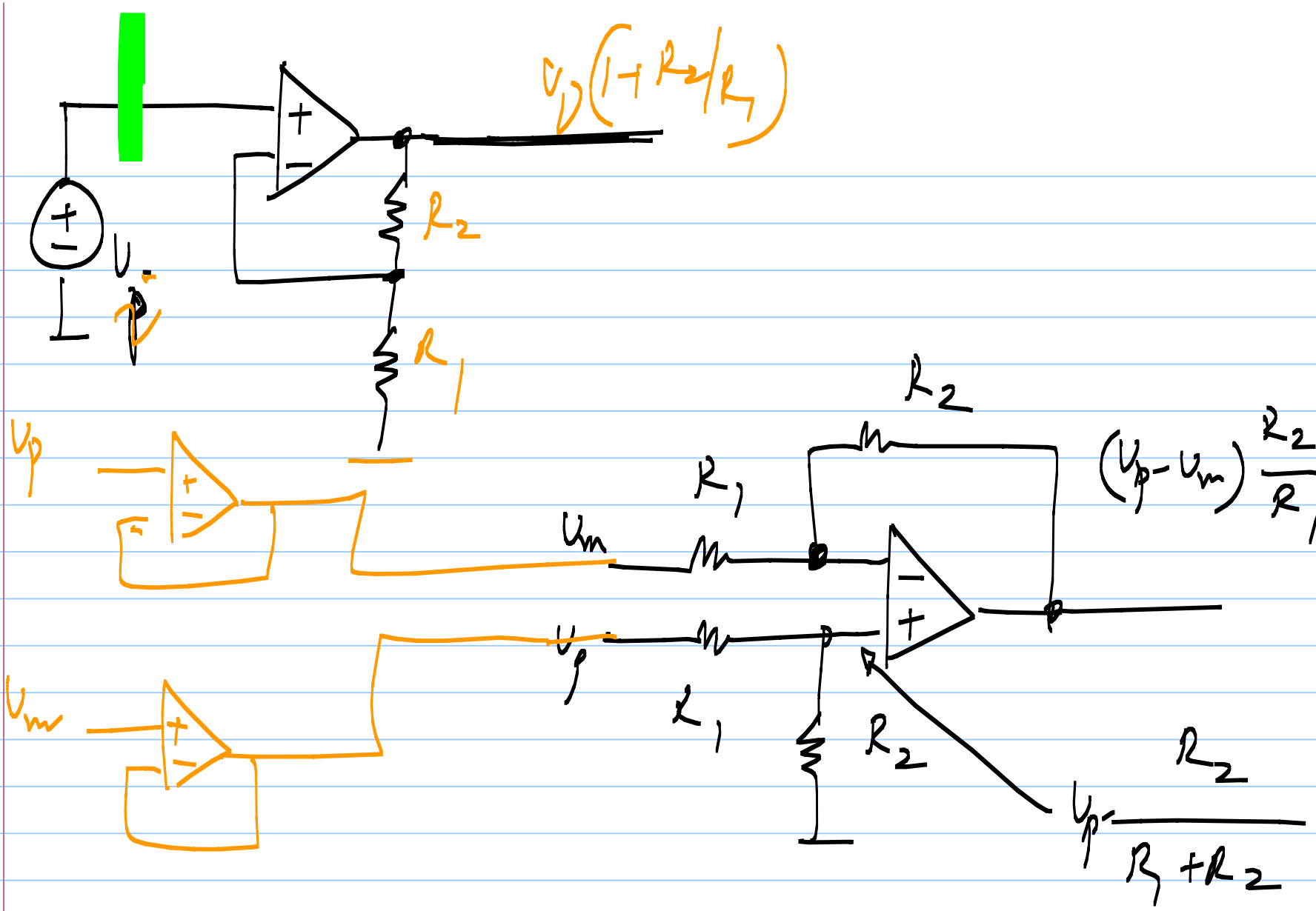
17/3/2017



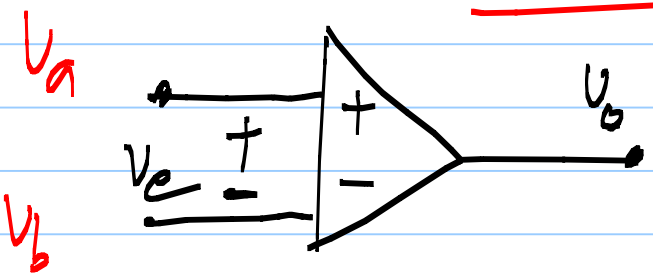


$(k_1 \cdot v_p - k_2 \cdot v_m)\, k_3$

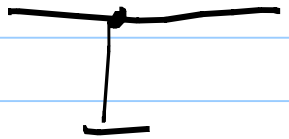



$V_i(1+R_2/R_1)$
V_i
R_2
R_1
V_p
V_m
R_2
R_1
$(V_p - V_m)\frac{R_2}{R_1}$
V_m
V_p
R_1
R_2
$V_p \frac{R_2}{R_1 + R_2}$

$$V_o = \alpha \cdot V_a + \beta V_b$$



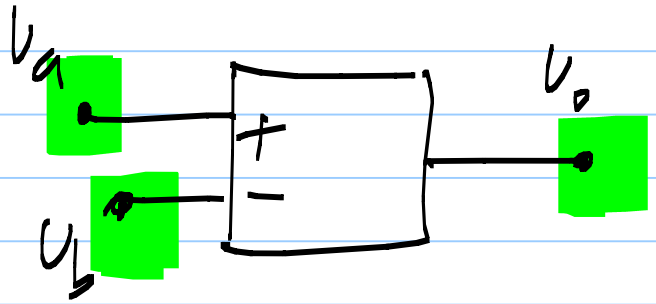
$V_o = A_o \cdot V_c$ ✗

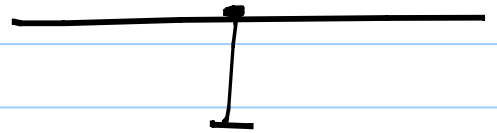


$$V_d = (V_a - V_b)$$

differential component

$$V_{cm} = \frac{V_a + V_b}{2}$$





$$V_o = \alpha \cdot V_a + \beta \cdot V_b$$

v_a, v_b

$$v_o = \alpha v_a + \beta \cdot v_b$$

$$= \left(\frac{\alpha - \beta}{2}\right) v_d + (\alpha + \beta) v_{cm}$$

Differential voltage $v_d = v_a - v_b$

Common-mode voltage $v_{cm} = \frac{v_a + v_b}{2}$ (average)

Common mode gain

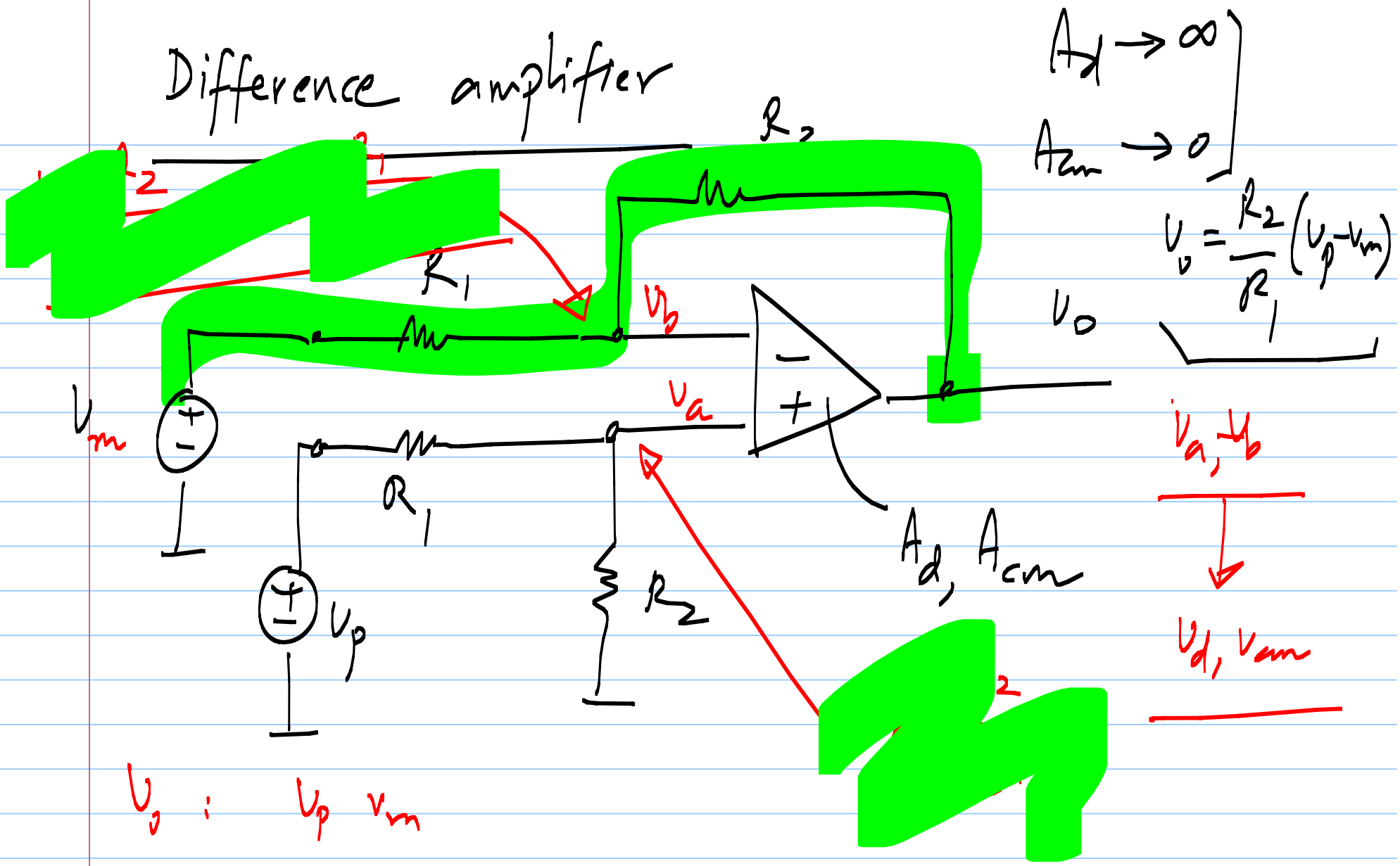
$$v_a = [redacted]$$

$$v_b = [redacted]$$

$$= A_d \cdot v_d + A_{cm} \cdot v_{cm}$$

Differential gain

Difference amplifier



$A_d \to \infty$

$A_{cm} \to 0$

$$v_o = \frac{R_2}{R_1}(v_p - v_m)$$

v_a, v_b

v_d, v_{cm}

v_o : v_p v_m

$$V_d = (V_p - V_m) \cdot \frac{R_2}{R_1 + R_2}$$

$$V_{cm} = \frac{V_p + V_m}{2} \cdot \frac{R_2}{R_1 + R_2} - \frac{V_o}{2} \cdot \frac{R_1}{R_1 + R_2}$$

$$V_o = A_d \cdot V_d + A_{cm} \cdot V_{cm}$$

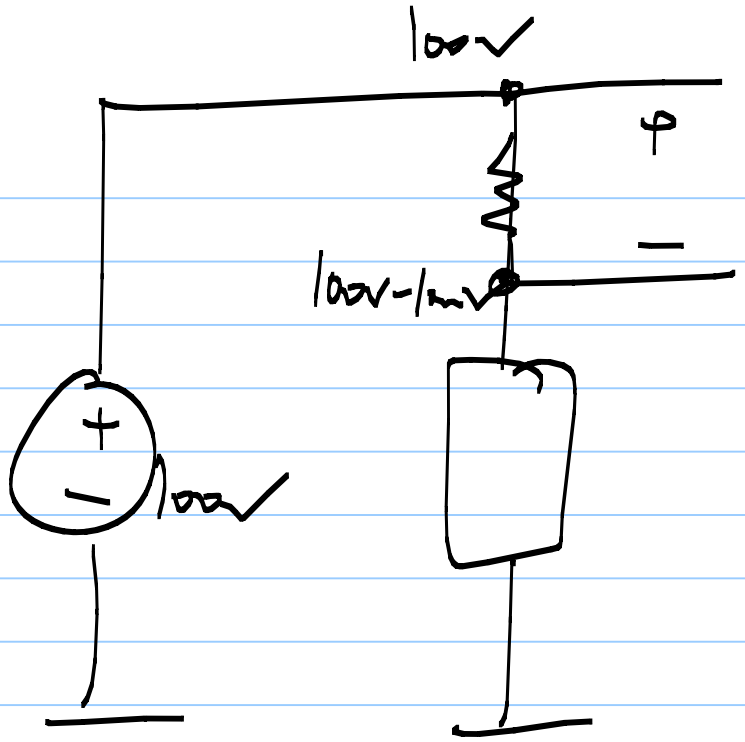
$$= A_d \cdot (V_p - V_m) \cdot \frac{R_2}{R_1 + R_2} - A_d \cdot V_o \cdot \frac{R_1}{R_1 + R_2} + A_{cm} \left(\frac{V_p + V_m}{2} \right) \cdot \frac{R_2}{R_1 + R_2} + \frac{A_{cm}}{2} \cdot V_o \cdot \frac{R_1}{R_1 + R_2}$$

$$V_o = \frac{A_d \cdot (V_p - V_m) \frac{R_2}{R_1 + R_2} + A_{cm} \left(\frac{V_p + V_m}{2} \right) \cdot \frac{R_2}{R_1 + R_2}}{1 + \left(A_d - \frac{A_{cm}}{2} \right) \cdot \frac{R_1}{R_1 + R_2}}$$

$$U_0 = \frac{A_d \cdot (U_p - U_m)\,\frac{R_2}{R_1+R_2} + A_{cm}\left(\frac{U_p+U_m}{2}\right)\cdot\frac{R_2}{R_1+R_2}}{1 + \left(A_d - \frac{A_{cm}}{2}\right)\cdot[\,\cdot\,]} \;\Big|\; \div A_d \cdot \frac{R_1}{R_1+R_2}$$

$$= \underbrace{(U_p - U_m)}_{10mV} \cdot \frac{R_2}{R_1} \cdot \frac{1}{1 - [\,\cdot\,] + [\,\cdot\,]}$$

$$+ \left(\overbrace{\underbrace{U_p + U_m}_{2}}^{100V}\right) \cdot \frac{R_2}{R_1} \cdot \left(\frac{[\,\cdot\,]}{A_d}\right) \qquad \frac{A_{cm}}{A_d} < 10^{-4}$$



Common-mode rejection ratio

$$\frac{A_d}{A_{cm}}$$