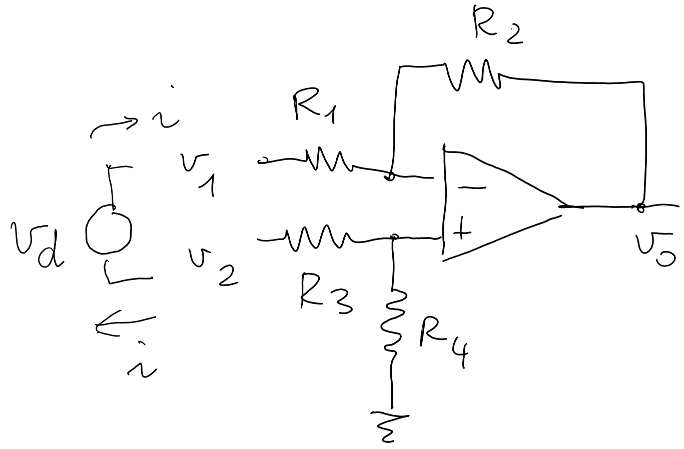


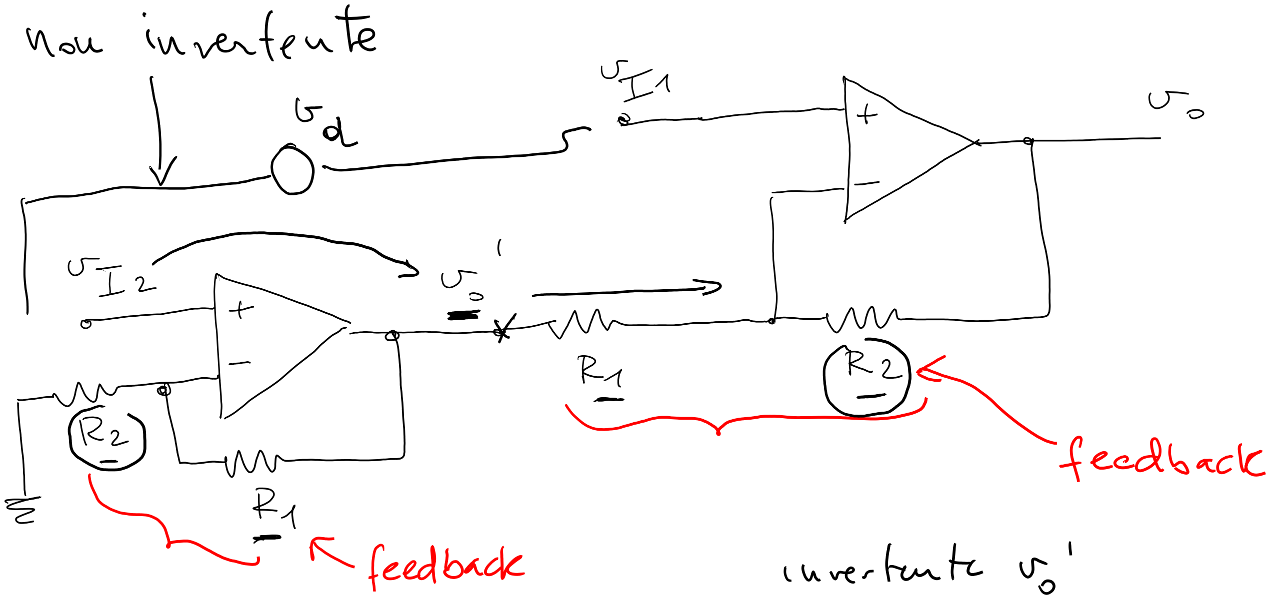
if $\dfrac{R_2}{R_1} = \dfrac{R_4}{R_3}$

$$v = A_d (v_2 - v_1) \; ; \; A_d = \frac{R_2}{R_1} = \frac{R_4}{R_3}$$

$$A_{cm} = \left. \equiv 0 . \right|_{\frac{R_2}{R_1} = \frac{R_4}{R_3}} \; !$$

$$v_{cm} = \frac{v_1 + v_2}{2} \Rightarrow \underline{\underline{\text{noise}}}$$

$$\boxed{A_d = \frac{R_2}{R_1} \qquad R_d = \frac{v_d}{i} = 2R_1}$$



invertente v_o'

non invertente v_{I1}

$$v_o' = v_{I2}\left(1 + \frac{R_1}{R_2}\right)$$

$$v_o = \underbrace{v_{I1}\left(1 + \frac{R_2}{R_1}\right)}_{\text{non inv.}} - \underbrace{v_o' \frac{R_2}{R_1}}_{-\frac{R_2}{R_1}\ \text{amplif. inv.}}$$

$$v_o' = v_{I_2}\left(1+\frac{R_1}{R_2}\right) \quad 1^\circ \text{ OPAMP}$$

$$2^\circ \text{ OPAMP} \quad v_o = v_{I_1}\left(1+\frac{R_2}{R_1}\right) - v_o'\frac{R_2}{R_1}$$

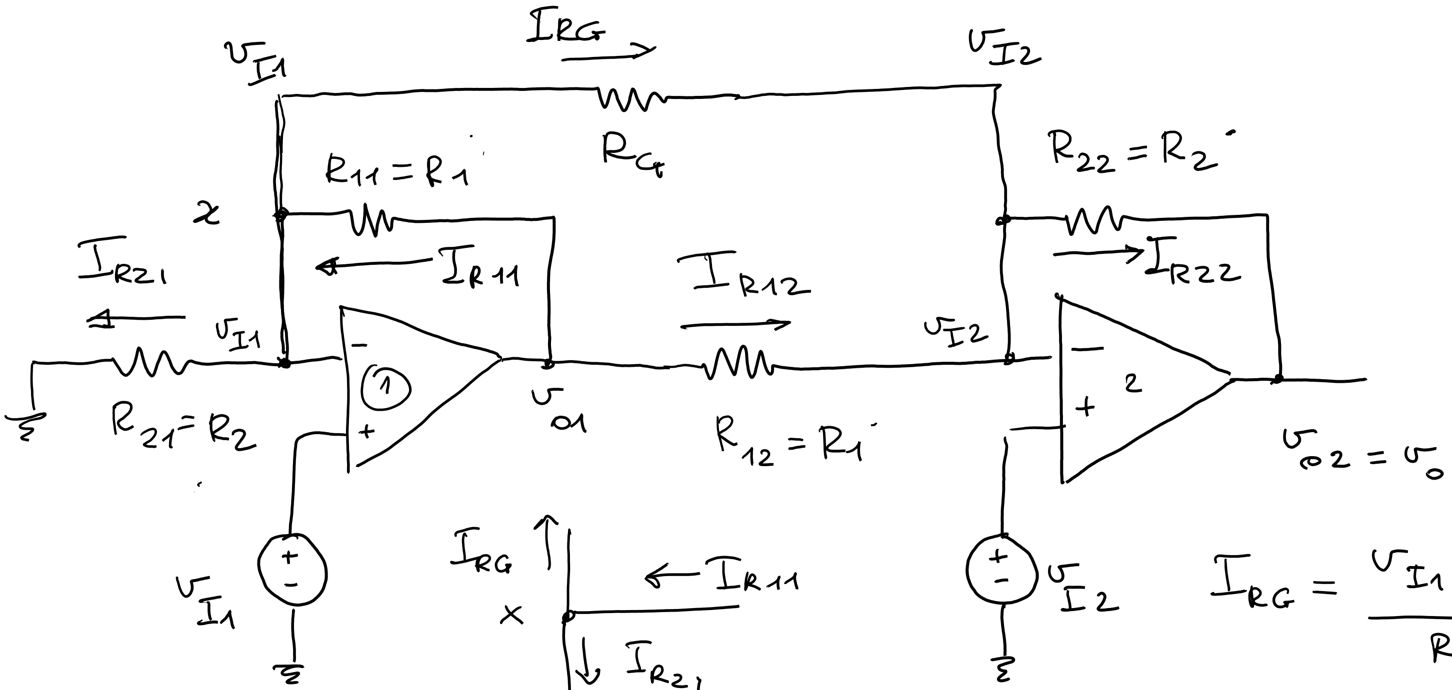
$$v_o = v_{I_1}\left(1+\frac{R_2}{R_1}\right) - v_{I_2}\left(1+\frac{R_1}{R_2}\right)\frac{R_2}{R_1}$$

$$= v_{I_1}\left(1+\frac{R_2}{R_1}\right) - v_{I_2}\left(\frac{R_2}{R_1}+1\right)$$

$$R_{id} = \infty$$

$$R_o = 0$$

$$= \left(v_{I_1} - v_{I_2}\right)\left(1+\frac{R_2}{R_1}\right) \; ; \quad \underline{A_d = \left(1+\frac{R_2}{R_1}\right)}$$



$$I_{RG} = \frac{v_{I1} - v_{I2}}{R_G} \quad ③$$

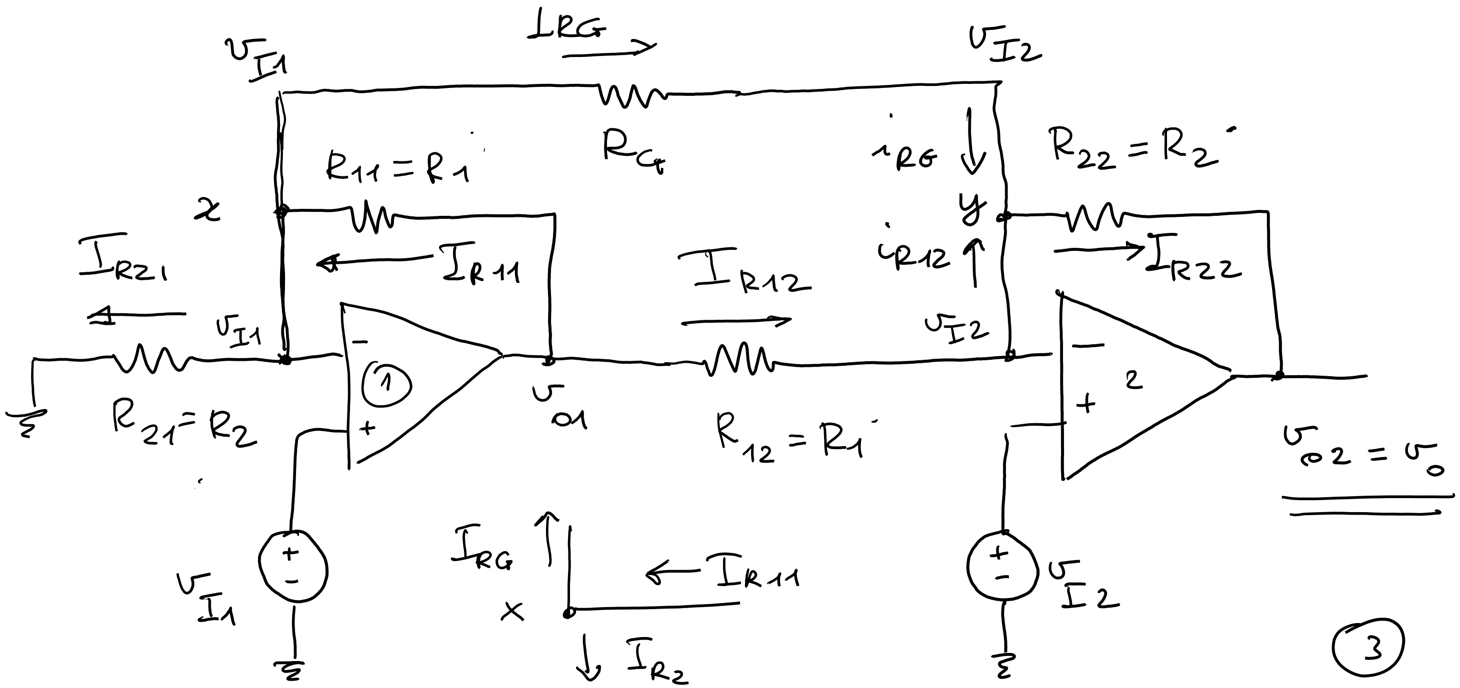
$$\underbrace{I_{R11} = I_{R21} + I_{RG}}$$

$$\underbrace{I_{R21} = \frac{v_{I1}}{R_2}}$$

$$\underline{I_{R11} = \frac{v_{o1} - v_{I1}}{R_1}}$$

①

$$\underset{①}{\frac{v_{o1} - v_{I1}}{R_1}} = \underset{②}{\frac{v_{I1}}{R_2}} + \underset{③}{\frac{v_{I1} - v_{I2}}{R_G}}$$



2° operazionale

(1)
$$i_{R12} = \frac{v_{o1} - v_{I2}}{R_1}$$

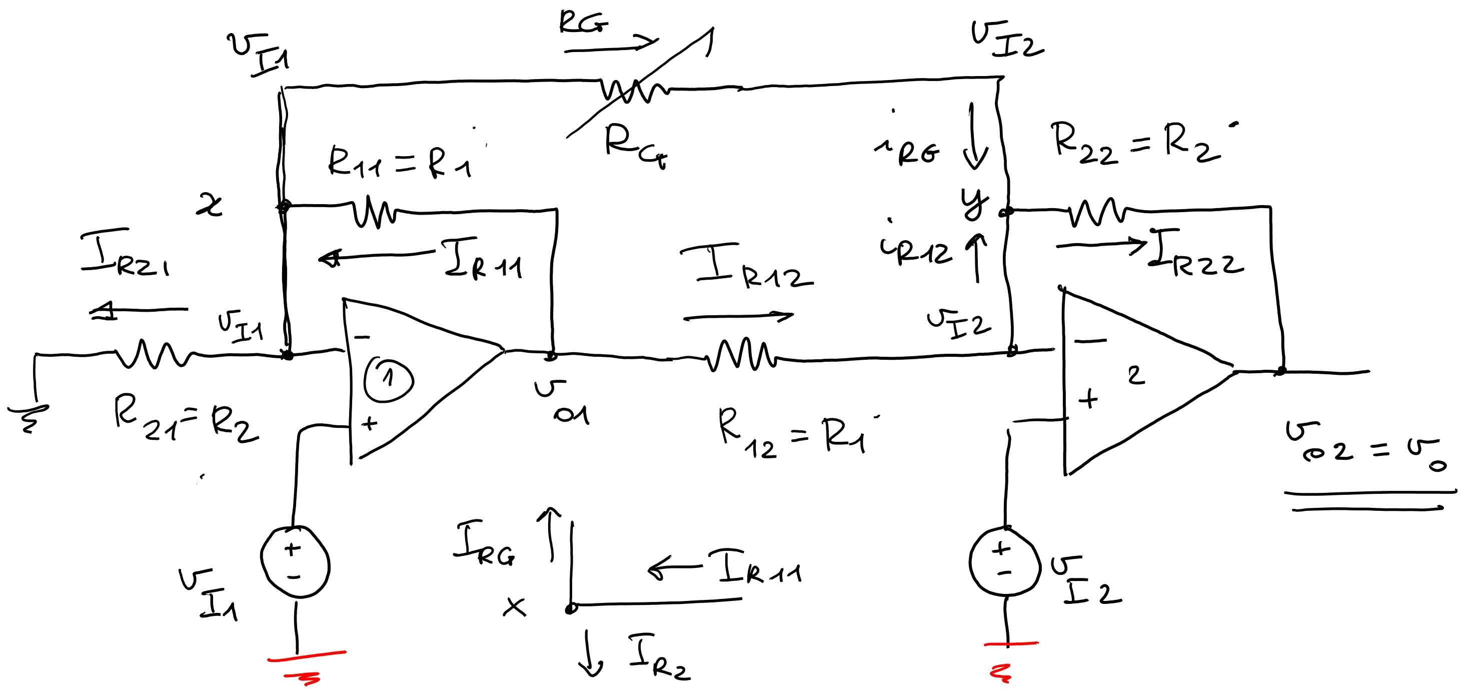
(2)
$$i_{RG} = \frac{v_{I1} - v_{I2}}{R_G}$$

$$i_{R22} = \underbrace{i_{R12} + i_{RG}}_{\text{somma delle correnti in } y}$$

(3)
$$i_{R22} = \frac{v_{o2} - v_{I2}}{R_2}$$

$$\underbrace{\frac{v_{o1}}{R_1} - \frac{v_{I2}}{R_1}}_{I_{R12}} + \underbrace{\frac{v_{I1} - v_{I2}}{R_G}}_{I_{RG}} = \underbrace{\frac{v_{I2} - v_o}{R_2}}_{I_{R22}}$$

$$\frac{v_{o1}}{R_1} - \frac{v_{I2}}{R_1} - \frac{v_{I2}}{R_2} + \frac{v_{I1} - v_{I2}}{R_G} = - \frac{v_o}{R_2}$$



$$\frac{v_{O1}}{R_1} = \frac{v_{I1}}{R_1} + \frac{v_{I1}}{R_2} + \frac{v_{I1} - v_{I2}}{R_G} \qquad \text{nodo } x$$

$$\frac{v_{O1}}{R_1} - \frac{v_{I2}}{R_1} - \frac{v_{I2}}{R_2} + \frac{v_{I1} - v_{I2}}{R_G} = -\frac{v_O}{R_2} \qquad \text{nodo } y$$

$\Downarrow$ si dimostra che:

$$v_O = (v_{I2} - v_{I1})\left(1 + \frac{R_2}{R_1}\right) + (v_{I2} - v_{I1}) \cdot \frac{2R_2}{R_G}$$

$$v_o = \underbrace{\left(1 + \frac{R_2}{R_1} + \frac{2R_2}{R_G}\right)}_{A_d} \underbrace{\left(v_{I2} - v_{I1}\right)}_{v_d} = A_d v_d$$

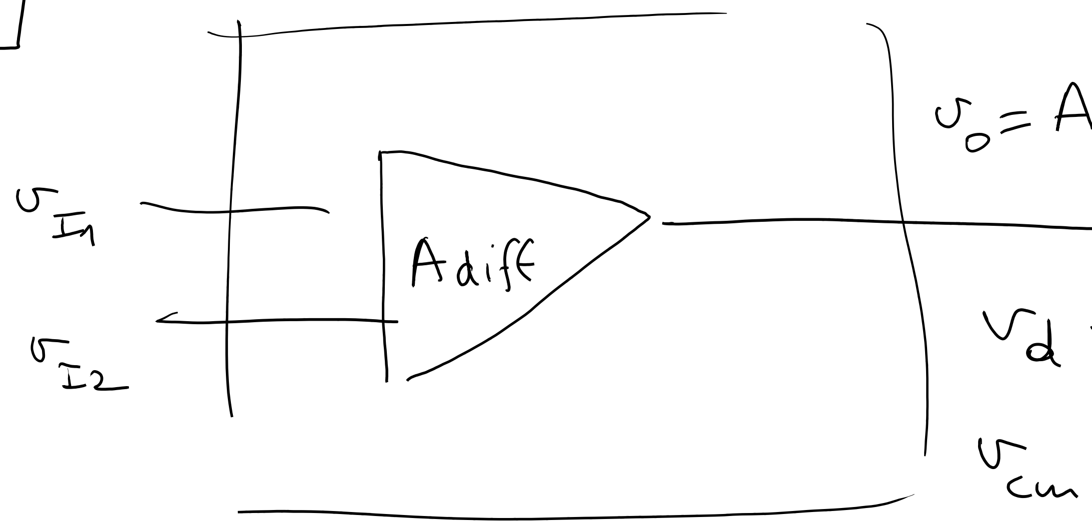
$$v_o = A_{cm} v_{cm} \Rightarrow v_d = 0 \qquad v_{I2} - v_{I1} = 0 \qquad v_{I1} = 2\,V$$

$$= 0. \Rightarrow \boxed{A_{cm} = 0}$$

$$v_{cm} = \frac{v_{I1} + v_{I2}}{2} = 2\,V \qquad v_{I2} = 2\,V$$

$$v_d = v_{I2} - v_{I1}$$

$$v_{cm} = \frac{v_{I2} + v_{I1}}{2}$$



$$v_o = A_d v_d + A_{cm} v_{cm}$$

$$v_d = 0$$

$$v_{cm} = \frac{v_{I1} + v_{I2}}{2}$$

v_d puro

$v_{I_1} = 3V$

$v_{I_2} = 2V$

$v_d = v_{I_2} - v_{I_1} = -1V$

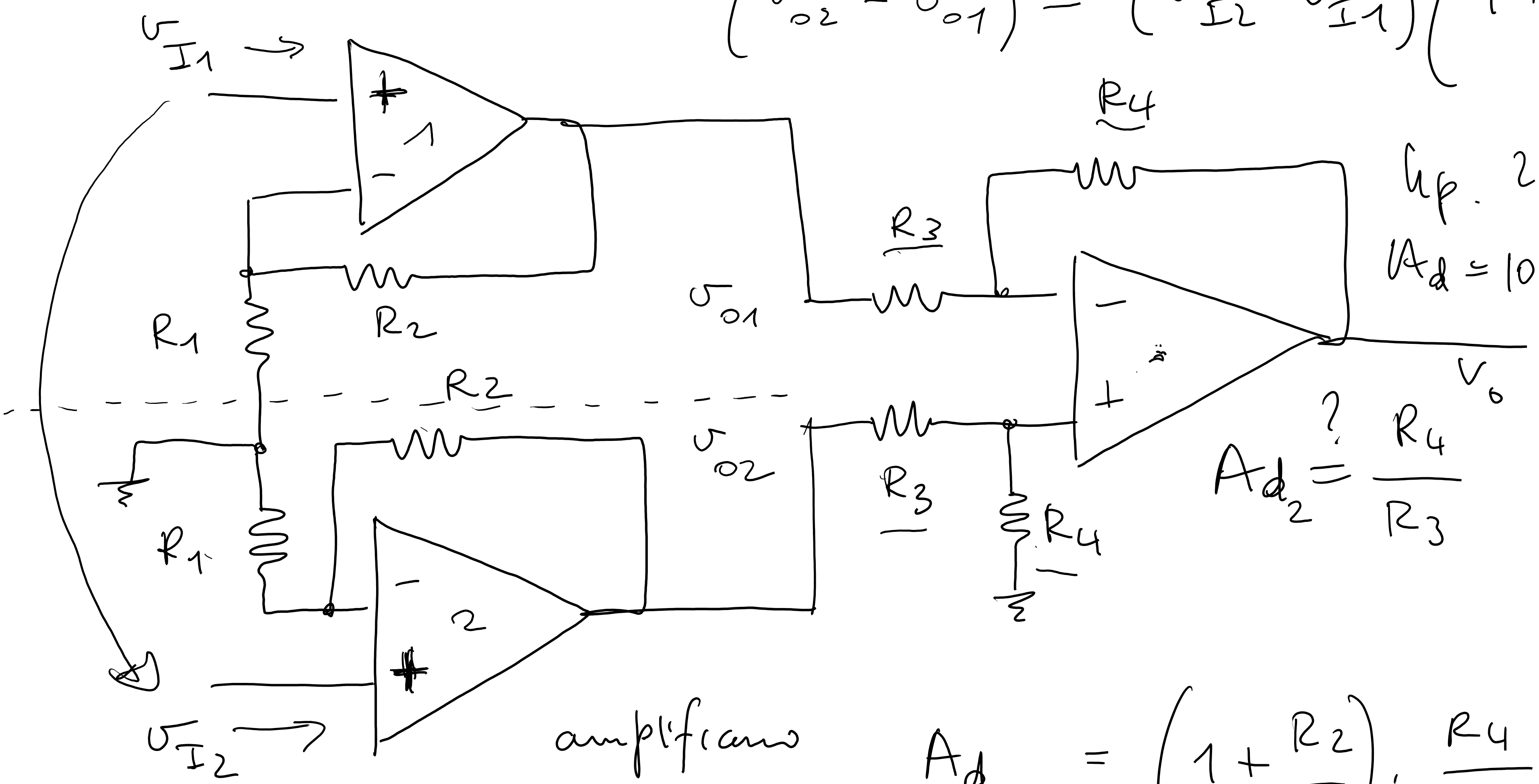
$v_{cm} = \frac{3+2}{2} = 2.5V$

$\neq$

$$\boxed{\begin{gathered} v_d \neq 0 \\ \underline{\underline{v_{cm} = 0}} \end{gathered}}$$

AMPLIFICATORE PER STRUMENTAZIONE

$$(v_{o2} - v_{o1}) = (v_{I2} - v_{I1})\left(1 + \frac{R_2}{R_1}\right)$$



Ip. 2° non ideale

$A_d = 100 \quad A_{cm} = 10^{-1}$

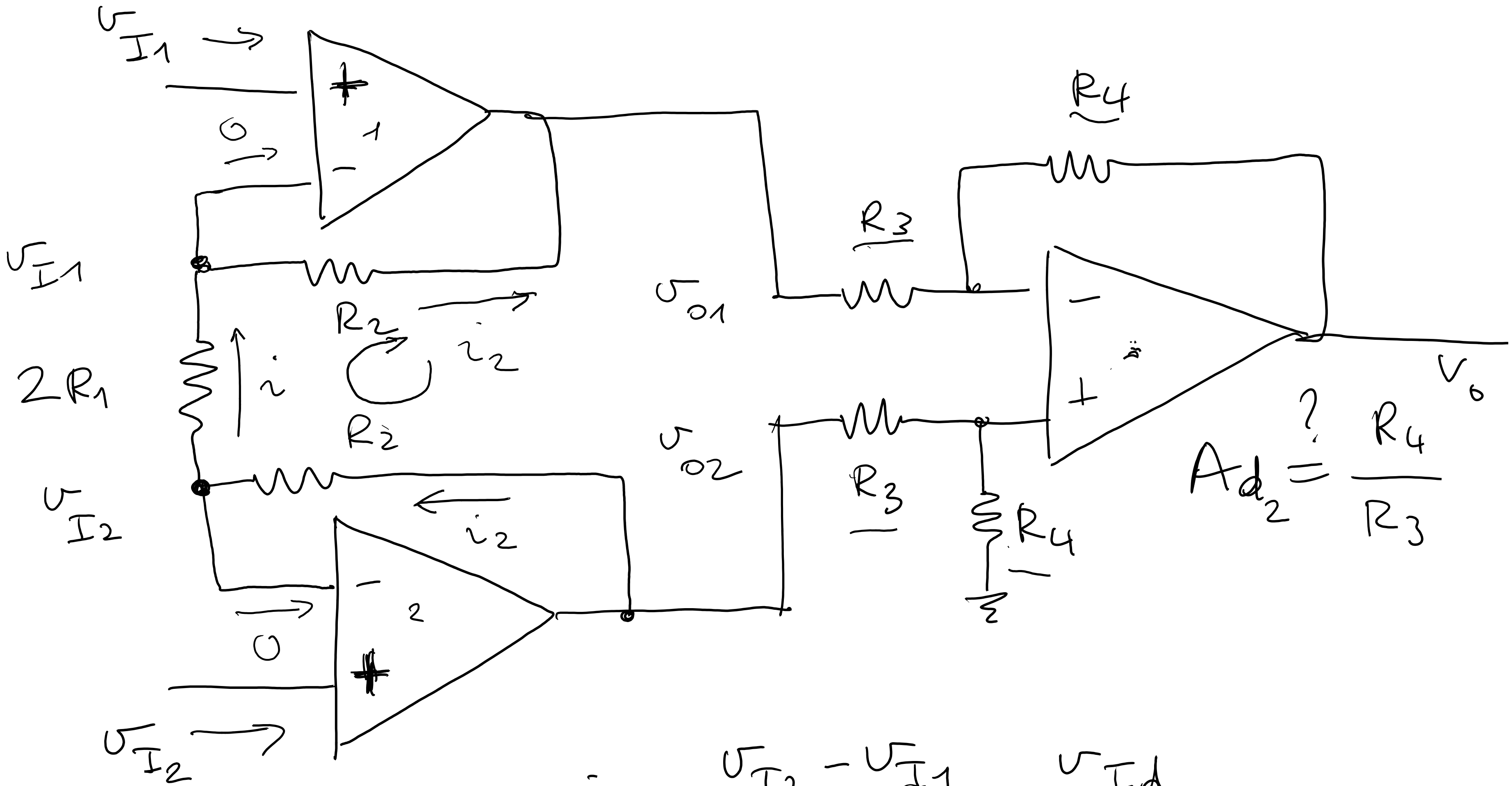
$$A_{d_2} \overset{?}{=} \frac{R_4}{R_3}$$

amplificano v_{I1} e v_{I2} separatamente

$$A_{d\,totale} = \left(1 + \frac{R_2}{R_1}\right) \cdot \frac{R_4}{R_3}$$

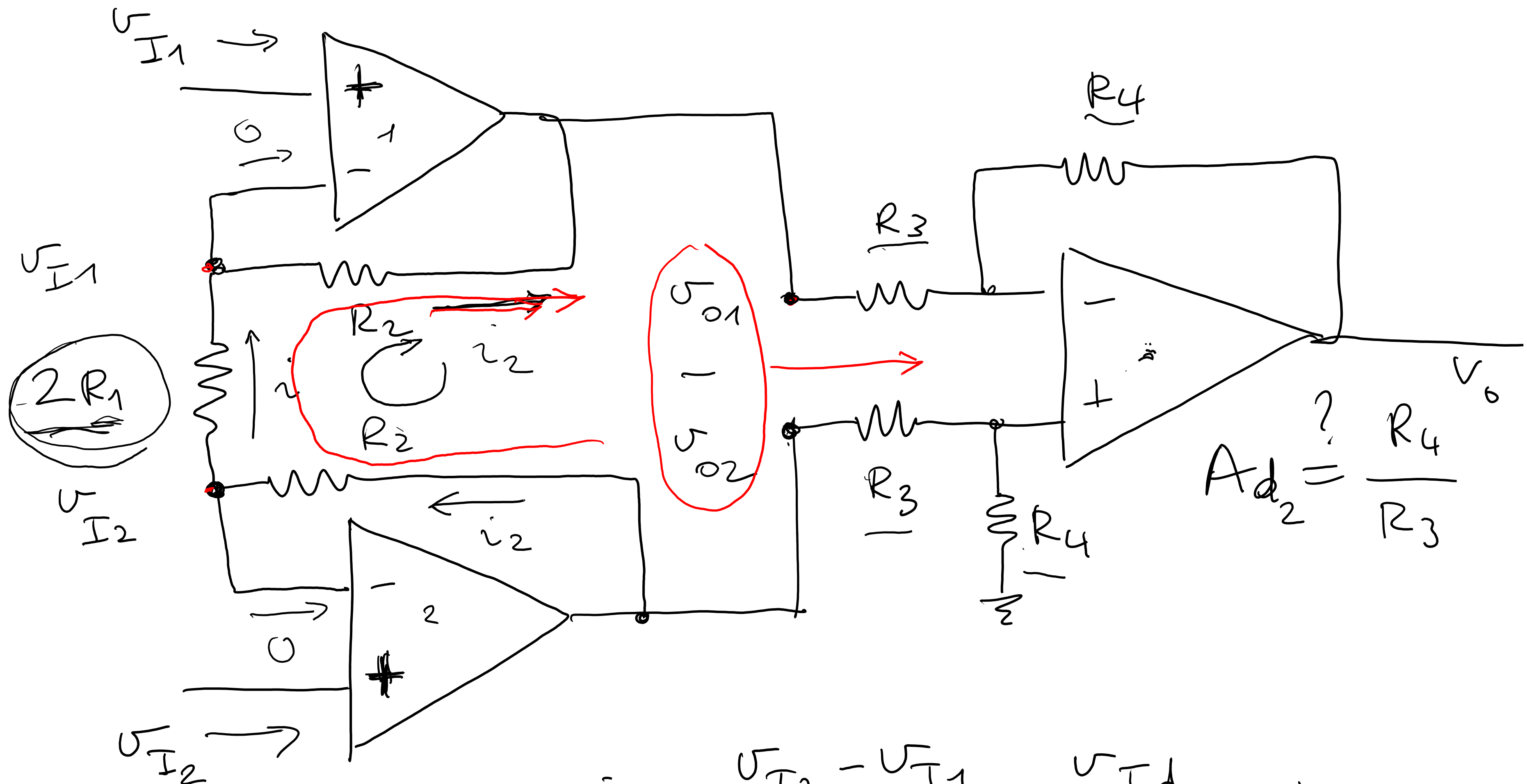
2 amplificatori **NON** invertenti

$R_{id} = \infty$



$$A_{d_2} \overset{?}{=} \frac{R_4}{R_3}$$

$$i = \frac{v_{I_2} - v_{I_1}}{2R_1} = \frac{v_{Id}}{2R_1}$$



$$A_{d_2} \overset{?}{=} \frac{R_4}{R_3}$$

$$i = \frac{v_{I_2} - v_{I_1}}{2R_1} = \frac{v_{Id}}{2R_1} = i_2$$

$$v_{o1} = v_{1I} - i_2 R_2$$

$$v_{o1} = v_{1I} - \underbrace{\frac{v_{Id}}{2R_1}}_{i_2} \cdot R_2$$

$$v_{o2} = v_{I_2} + i_2 R_2 = v_{I_2} + \frac{v_{ID}}{2R_1} \cdot R_2$$

$$v_{o2} - v_{o1} = v_{I_2} - v_{I_1} + \underbrace{\frac{v_{ID}}{2R_1} R_2 - \left(- \frac{v_{ID}}{2R_1} \cdot R_2 \right)}$$

$$= \underbrace{v_{I_2} - v_{I_1}}_{v_{Id}} + v_{ID} \cdot \frac{R_2}{R_1}$$

$$\underline{v_{o2} - v_{o1}} = v_{id} \left(1 + \frac{R_2}{R_1} \right) \leftarrow$$ segnale diff. di ingresso per il 2° stadio

$$v_{o\,totale} = v_{id} \frac{R_4}{R_3} \left(1 + \frac{R_2}{R_1} \right)$$