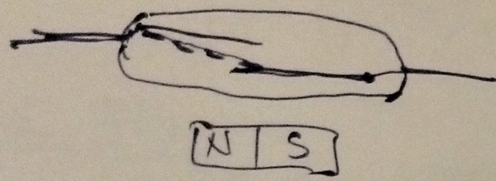
Reed switch:



Senzori de temperatură:

$$\frac{\Delta L}{L_0}(T);\ \rho(T);\ t.e.m(T);\ \varepsilon_r(T);\ \Delta Q(\Delta T).$$

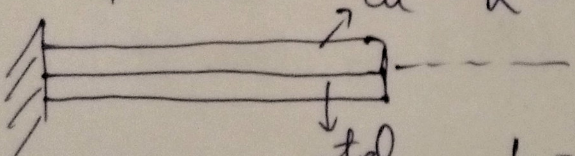
Termometrul bimetalic:

$$\alpha_V = \frac{1}{V}\cdot\left(\frac{\partial V}{\partial T}\right)_{p=ct}.$$

liniar $\frac{\Delta L}{L_0} = \alpha\cdot\Delta T.$

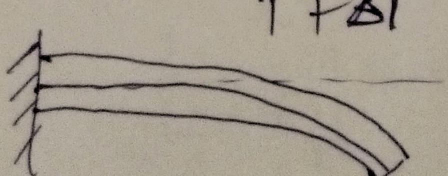
T=300K

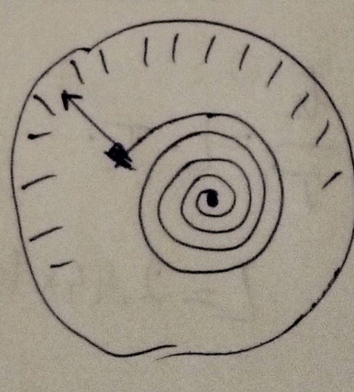
Cu $\alpha = 17\times 10^{-6}/^\circ C.$



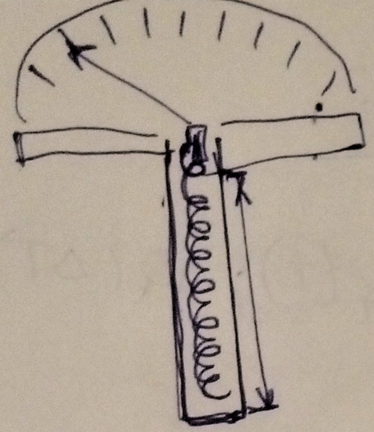
oțel $\alpha = 13\times 10^{-6}/^\circ C.$

T+ΔT





-30° - 500°C



Termometre rezistive

RTD.

rezistance temperature detector.

Legea Wiedemann-Franz.

$$\frac{k}{\sigma} = L \cdot T.$$

$$L = 2{,}44 \times 10^{-8}\ W \Omega K^{-2}$$

$$\rho = \rho_0 \left(1+\alpha\cdot(T-T_0)\right).$$

$$\rho_0 = \rho_1(T_0).$$

•) ~~Pt.~~ Pt100:

$-200^\circ C \leq T \leq 0^\circ C$

$$\rho(T) = \rho_0 (1 + A\cdot T + BT^2 + C(T-100)\cdot T^3).$$

•) $0^\circ C \leq T \leq 850^\circ C$

$$\rho(T) = \rho_0 (1 + A\cdot T + BT^2)$$

Pt100: $A = 3.90802 \times 10^{-3}\ {}^\circ C^{-1}$

$B = -5.80195 \times 10^{-7}\ {}^\circ C^{-2}$

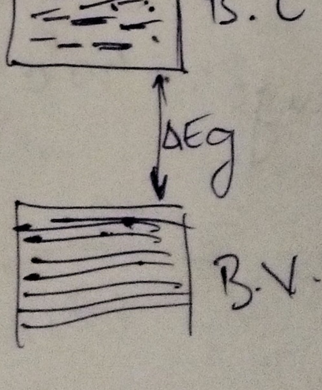
$C = -4.2735 \times 10^{-12}\ {}^\circ C^{-4}.$

Pt 100 $\rightarrow R(0^\circ C) = 100\ \Omega$

Pt1000 $\rightarrow R(0^\circ C) = 1000\ \Omega$

→ 2 fire
→ 3 fire
→ 4 fire

•) Termistori (NTC sau PTC):



la $T=0$ $\sigma \sim 0$.

$T \nearrow$ $\sigma \nearrow$

$\rho = \rho_0 e^{-\alpha T}$

Ecuația Steinhart-Hart.

$$\boxed{\frac{1}{T} = A + B\ln\rho + C\ln\rho^3}$$

$$A = \frac{1}{T_0} - \frac{1}{B}\ln\rho_0.$$

$$B = \frac{1}{\beta}.$$

$$C = 0.$$

$$\cancel{\frac{1}{T_0}} = \cancel{\frac{1}{T}} \quad \frac{1}{T} = \frac{1}{T_0} + \frac{1}{\beta}\ln\frac{R}{R_0}.$$

$$R = R_0 e^{\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)}.$$

$$R_0 = R(T_0)$$

$$T_0 = 25^\circ C.$$

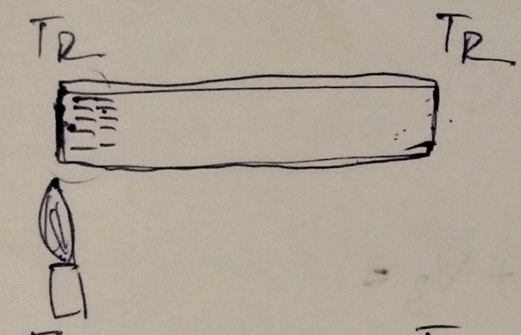
$$R = r_\infty e^{\frac{\beta}{T}}$$

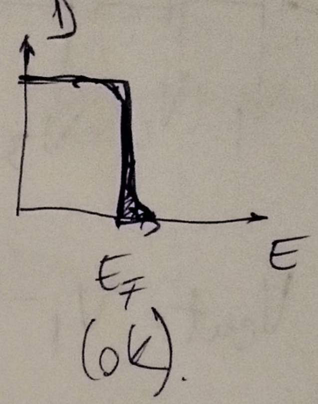
$$r_\infty = R_0 e^{-\frac{\beta}{T_0}}$$

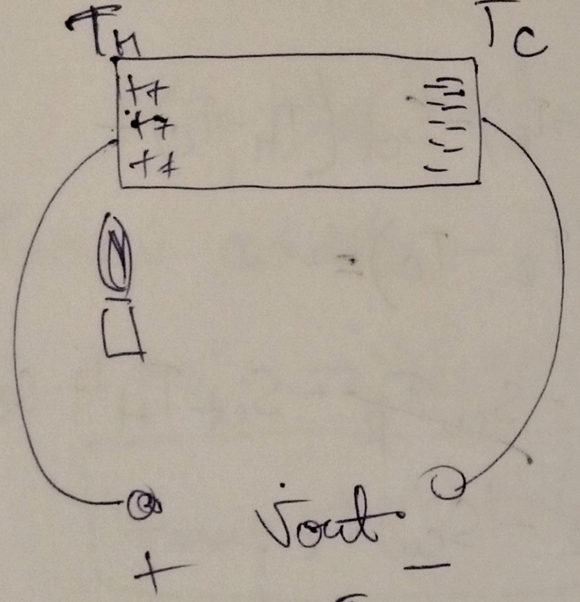
range: $-40^\circ C - 125^\circ C$

Termocuplul:

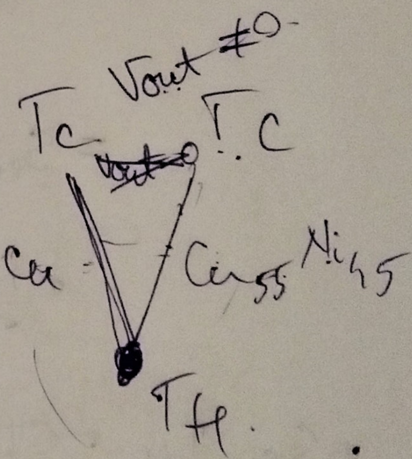
1) efectul Seebeck:





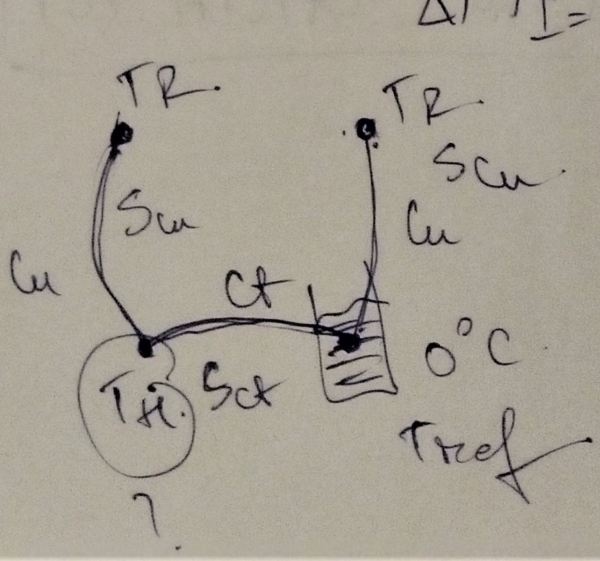


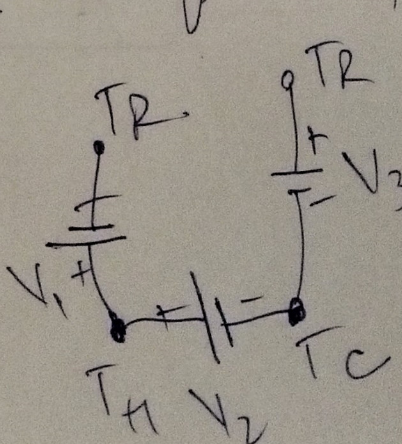
$$\Delta T = T_H - T_C$$



$$\Delta V = \int_{T_C}^{T_H} S(T)\,dT .$$

$$S = \frac{\Delta V}{\Delta T}\Big|_{I=0}.$$

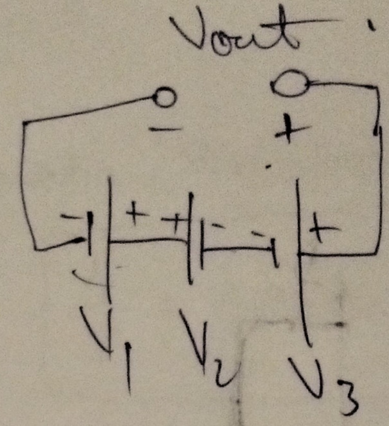




$V_1 = S_{Cu} \cdot (T_H - T_R)$

$V_2 = S_{Ct}(T_H - T_C)$

$V_3 = S_{Cu}(T_R - T_C)$



$$V_{out} = V_1 - V_2 + V_3 =$$

$$= S_{cu}(T_H - T_R) - S_{ct}(T_H - T_C) +$$

$$+ S_{cu}(T_R - T_C) =$$

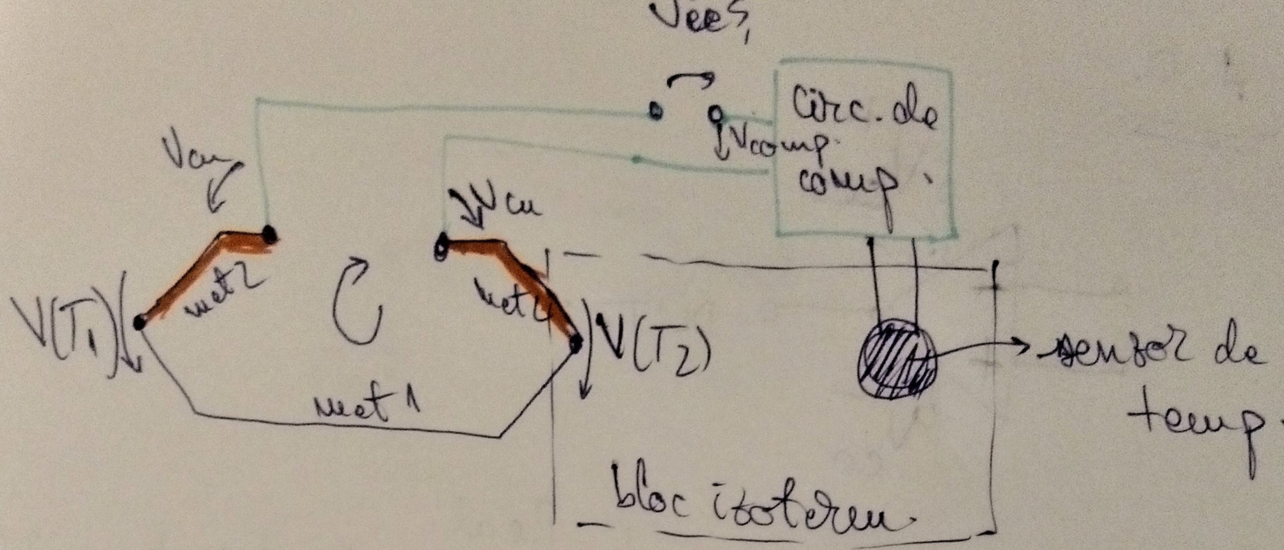
$$= S_{cu} \cdot T_H - \cancel{S_{cu} T_R} - S_{ct} T_H + S_{ct} \cdot T_C +$$

$$+ \cancel{S_{cu} T_R} - S_{cu} \cdot T_C.$$

$$= S_{cu} T_H - S_{cu} \cdot T_C - S_{ct} \cdot T_H + S_{ct} \cdot T_C =$$

$$= S_{cu} \cdot (T_H - T_C) - S_{ct}(T_H - T_C) \Rightarrow$$

$$\Rightarrow \boxed{V_{out} = (S_{cu} - S_{ct})(T_H - T_C)}.$$



$$V_{ieș_1} + \cancel{V_{cu}} + V_{comp} + V(T_2) - V(T_1) - \cancel{V_{cu}} = 0.$$

Punem condiția:

Dacă $T_1 = 0°C \rightarrow V_{ieș_1} = 0°C$

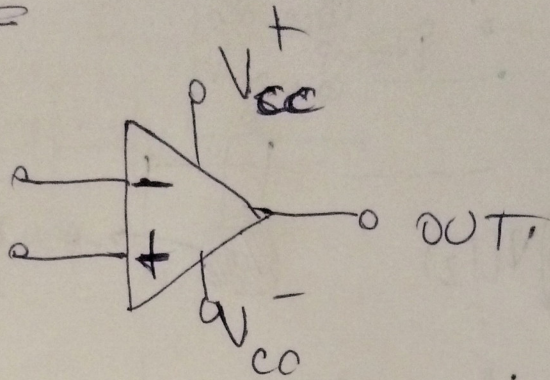
$$\boxed{V_{comp} - V(0°C) + V(T_2) = 0} \Rightarrow$$

$$\Rightarrow V_{comp} = -V(T_2) + V(0°C)$$

$$V_{ieș_1} - \cancel{V(T_2)} + V(0°C) + \cancel{V(T_2)} - V(T_1) = 0$$

$$\boxed{V_{ieș_1} = V(T_1) - V(0°C)}$$

A.O.



A.O. ideal

$Z_{in} \to \infty$

$Z_{out} \to 0$

$A_v \to \infty$

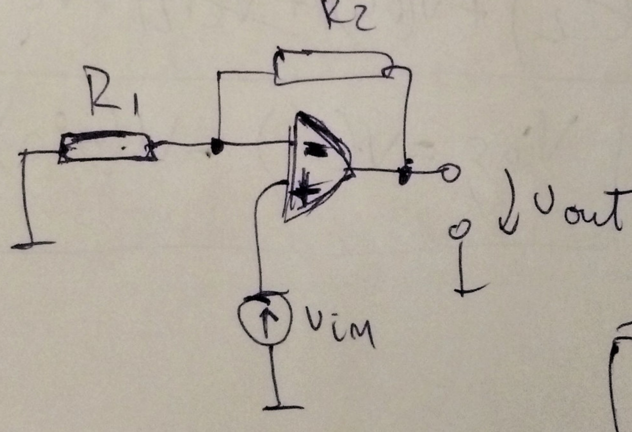
Real

BJT $Z_{in} \approx 200k\Omega - 2M\Omega$

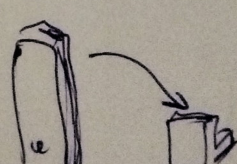
FET $Z_{in} \approx 10^{12}\,\Omega$

$$\boxed{v_{out} = (v_+ - v_-) \cdot A_v}$$

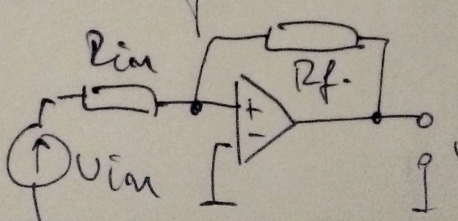
Negative feedback.



$$v_{out} = \left(1 + \frac{R_2}{R_1}\right) \cdot v_{in}$$



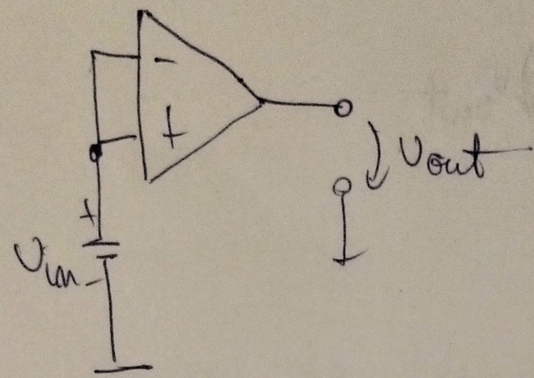
Positive feedback:



~~Vout~~

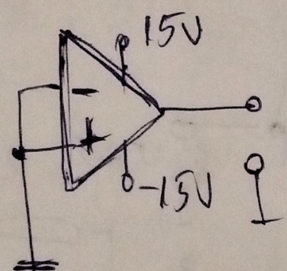
$v_{out} \approx V_{cc}^{+}$

common-mode gain:

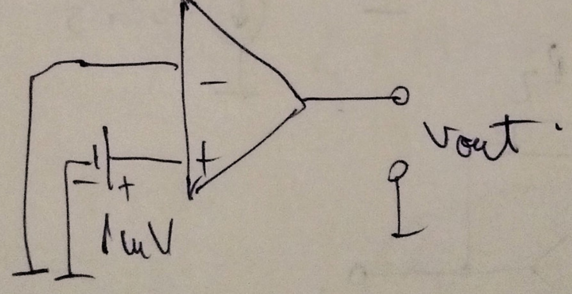


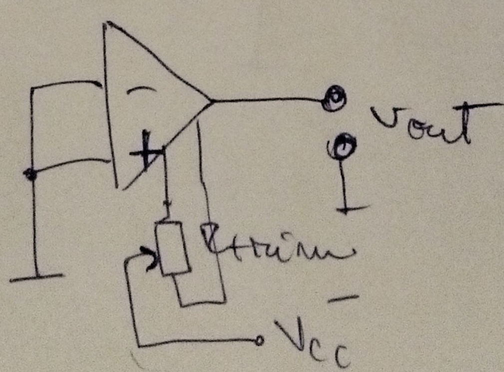
$$A_v^{CM} = \frac{\Delta V_{out}}{\Delta V_{in}} = 0 \text{ ideal}$$

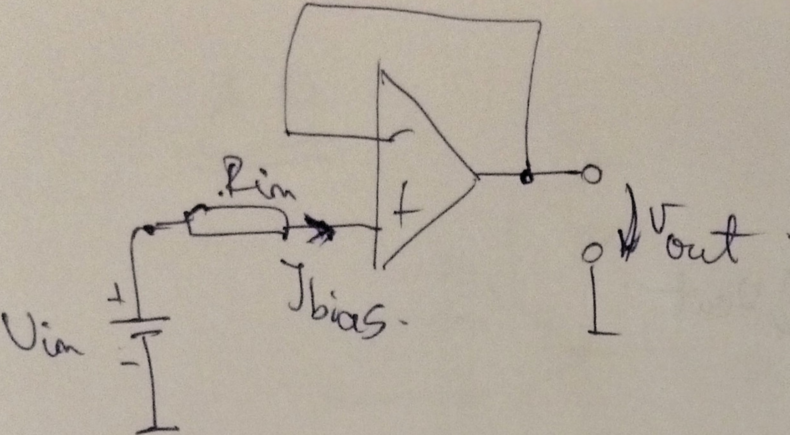
$$CMRR = \frac{A_v}{A_v^{CM}} \quad [dB].$$



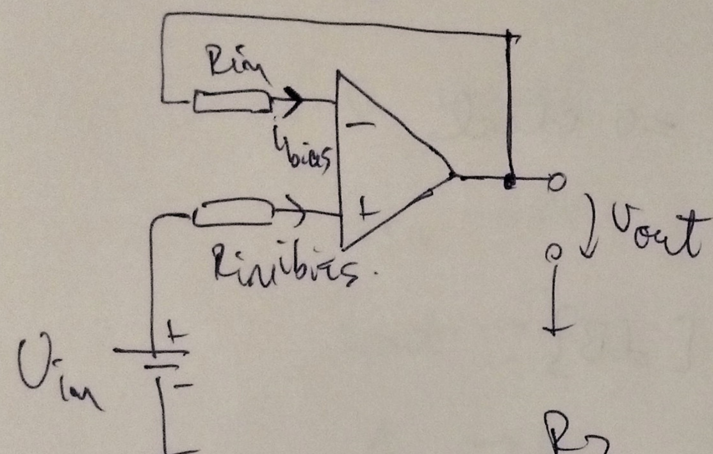
$v_{out} = +14.7V.$



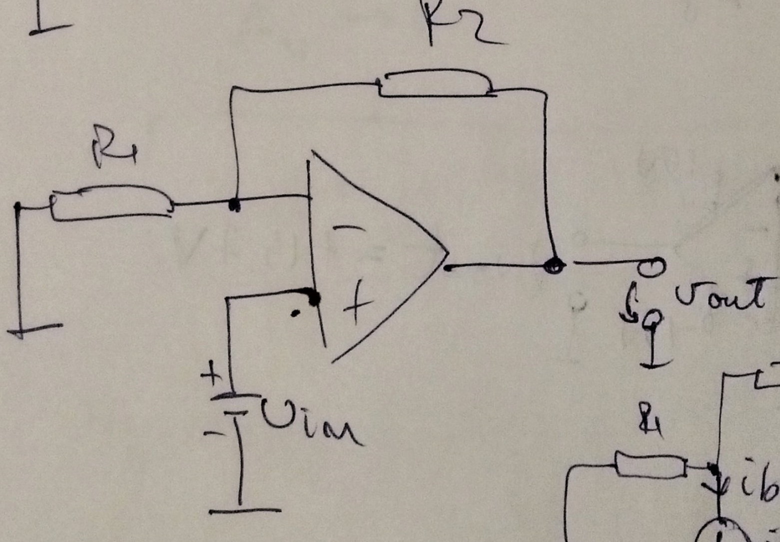




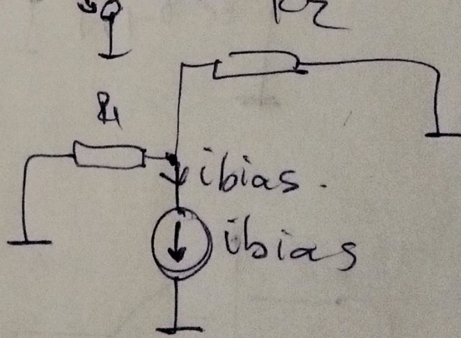
Rin
Ibias
Vout
Vin



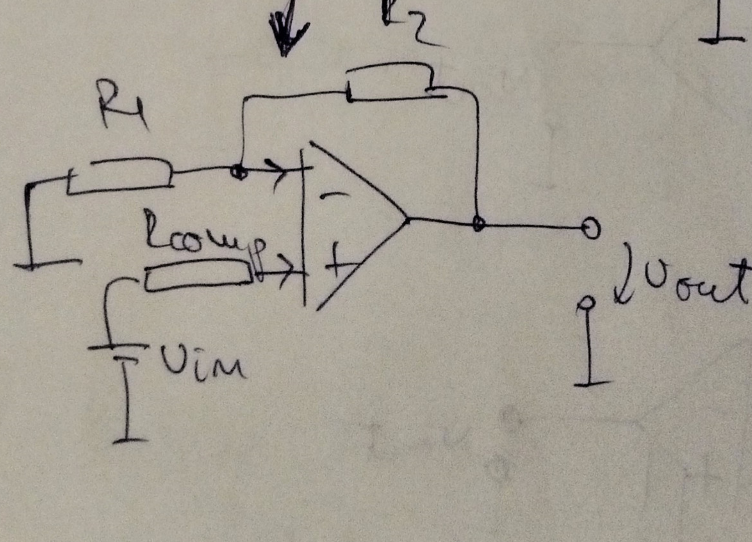
Rin
ibias
Vout
Rin ibias
Vin



R2
R1
Vout
Vin



R2
R1
ibias
ibias



R2
R1
Rcomp
Vout
Vin