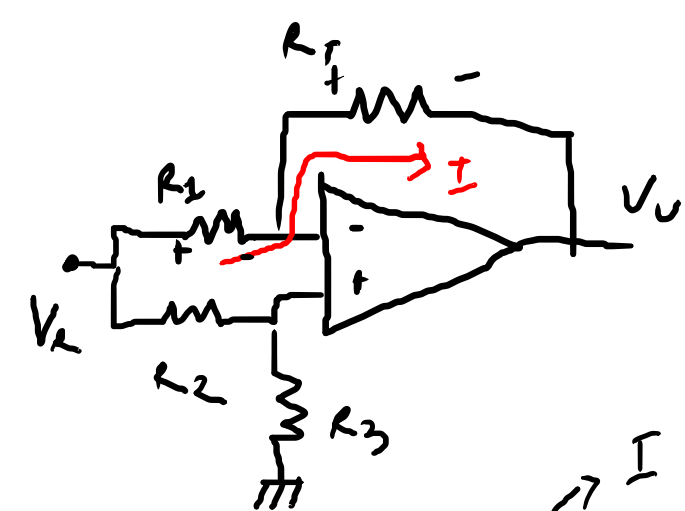


PUNTO 1



$$V^+ = V^-$$

$$I = \frac{V_R - V^-}{R_1}$$

$$V^- = V_R \frac{R_3}{R_2 + R_3}$$

$$V_U = V^+ - R_T I$$

$$I = \frac{V_R}{R_1} - \frac{V_R}{R_1} \frac{R_3}{R_2 + R_3}$$
$$\frac{V_R}{R_1} \left(\frac{R_2}{R_2 + R_3} \right) \rightarrow \frac{1}{2}$$
$$\underline{I} = \frac{V_R}{2R_1}$$

$$V_U = \frac{V_R R_3}{R_2 + R_3} \frac{R_2 R_1}{R_2 R_1} - R_T I$$

$$V_U = \frac{R_3 R_1}{R_2} I - R_T I = I \left(\frac{R_3 R_1}{R_2} - R_T \right)$$
$$\frac{R_3}{R_2} = \frac{R_T}{R_1}$$

$$V_U = I \left(\frac{R_3 R_1 - R_T R_2}{R_2} \right)$$

SE $R_3 R_1 = R_T R_2$

$$V_U = -I \alpha R \Delta T$$

$$V_U = I \left(\frac{R_3 R_1 - R_T R_2}{R_2} \right) \quad R(T) = R(T_0) e^{\left[B \left(\frac{1}{T} - \frac{1}{T_0} \right) \right]}$$

$$T_L = 36^\circ\text{C} \quad \bar{R} = R(T_0) e^{\left[B \left(\frac{1}{273+36} - \frac{1}{273+20} \right) \right]}$$

$$\bar{R} = 225.73 \, \Omega$$

$$\bar{\alpha} = TCR(T_L) = - \frac{B}{(36+273)^2}$$

$$\bar{\alpha} = -0.0471^\circ\text{C}^{-1}$$

$$R_L = \bar{R} (1 + \bar{\alpha} \Delta T) \quad \Delta T = T - T_L$$

$$R_L = \frac{I}{\cancel{R}} (R_3 R_1 - R_T \cancel{R}_2) = I (\cancel{R}_1 - \cancel{R} - \bar{R} \bar{\alpha} \Delta T)$$

$$R_L = -I \bar{R} \bar{\alpha} \Delta T$$

$$I = \frac{V_R}{2R_1} = 3 \text{ mA}$$

$$S = -I \bar{R} \bar{\alpha} = 0.032 \text{ V}/^\circ\text{C}$$

$$V_u = -0.08 \text{ V} \quad \Delta T_H = \frac{V_u}{S} = \frac{-0.08}{0.032} = -2.5^\circ \text{C}$$

$$T_H = \Delta T_H + T_L = 33.5^\circ \text{C}$$

$$\varepsilon_e = \frac{|\Delta V|}{|S|}$$

$$R_L(33.5^\circ \text{C}) = 252.31 \Omega$$

$$R(33.5^\circ \text{C}) = 254.20 \Omega$$

$$S = -I \bar{\alpha} \bar{R}$$

$$V = I(R_1 - R_T)$$

$$V_L = I(R_1 - R_L)$$

$$|\Delta V| = | \cancel{I} R_1 - \cancel{I} R_T - \cancel{I} R_1 + I R_L | = | I(R_L - R_T) |$$

$$= I |\Delta R|$$

$$\Rightarrow \varepsilon_e = \frac{\cancel{|I|} \cdot |\Delta R|}{\cancel{|I|} \cdot |\bar{\alpha} \bar{R}|} = \left| \frac{\Delta R}{S_R} \right| = \left| \frac{\Delta R}{\bar{\alpha} \bar{R}} \right|$$

$$\varepsilon_e = \frac{254.20 - 252.33}{225.73 \cdot 0.0471} = 0.18^\circ\text{C}$$

max ε_e [32-36]

32 $\rightarrow \frac{\Delta R}{S_R}$ 36 $\rightarrow \frac{\Delta R}{S_R}$

PUNT02

$$S = 0.032 \text{ V/C}$$

$$\Delta T = \frac{V_U}{S}$$

MAX

$$T = 32^\circ\text{C}$$

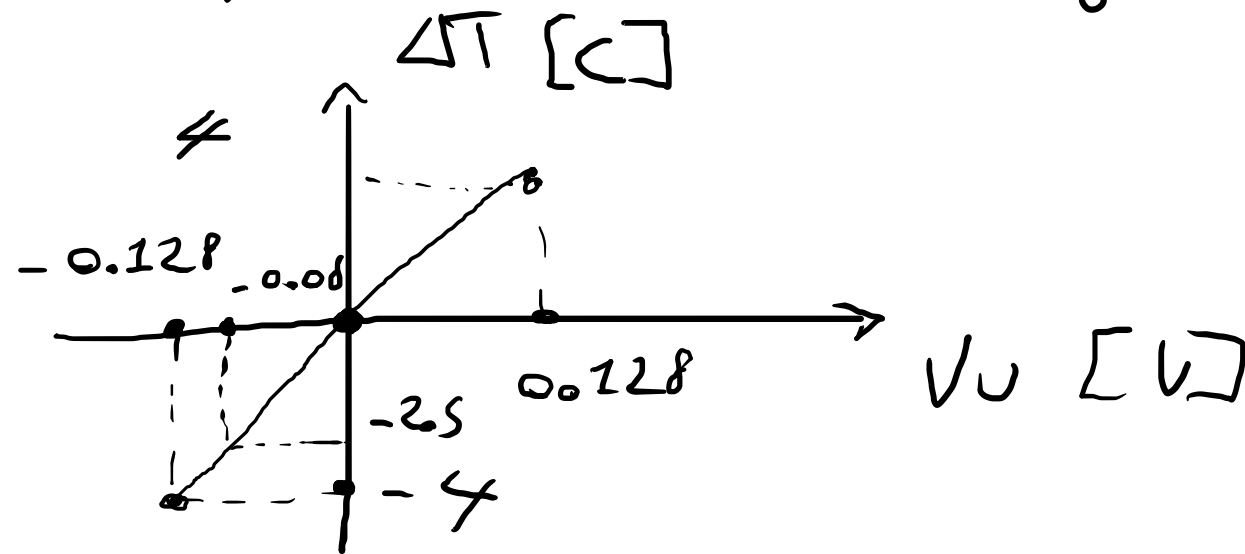
$$\Delta T = -4^\circ\text{C}$$

$$V_U = -4 \cdot 0.0032 = -0.128 \text{ V}$$

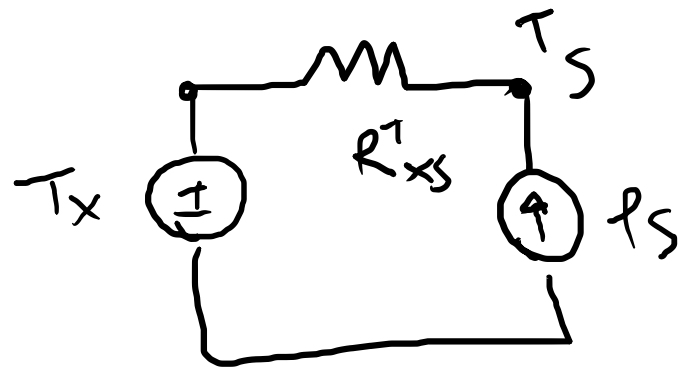
$$T = 36^\circ\text{C}$$

$$\Delta T = 4^\circ\text{C}$$

$$V_U = 0.128 \text{ V}$$



ESERCIZIO 3



$$T_s = T_x + R_{xs}^T P_s$$

$$0 < T_s - T_x = \underbrace{\Delta T = R_{xs}^T P_s}_{\text{AUTORISCALDAMENTO}}$$

$$P_s = R_T(T_s) I^2$$

$$R_L = \bar{R}_2 (1 + \bar{\alpha}_2 \Delta T)$$

$$\Delta T = T_s - T_x \quad \nearrow$$

LINEARIZZAZIONE \longrightarrow T_x

$$\bar{R}_2 = R_T(39 + 273) = 196.24 \Omega$$

$$\bar{\alpha}_2 = \frac{-\rho}{(39 + 273)^2} = -0.0462 \text{ } ^\circ\text{C}^{-1}$$

$$\Delta T = \frac{R_{xs}^T \bar{R}_2 I^2}{1 - \bar{\alpha}_2 R_{xs}^T \bar{R}_2 I^2}$$

$$I = ? \longrightarrow 3 \text{ mA}$$

$$\Delta T = 0.18^\circ\text{C}$$

$$T_s = T_x + \Delta T = 39.18^\circ\text{C}$$

$$\Delta T_M = \frac{V_U}{S} \quad V_U = I (R_1 - R_T(T_s)) \quad R_T(T_s) = 194.61 \, \Omega$$

$$\Delta T_M = \frac{I (R_1 - R_T(T_s))}{S} = \frac{R_1 - R_T(T_s)}{-\alpha \cdot R} = 2.93^\circ\text{C}$$

$$T_M = T_L + \Delta T_M = 38.93^\circ\text{C}$$

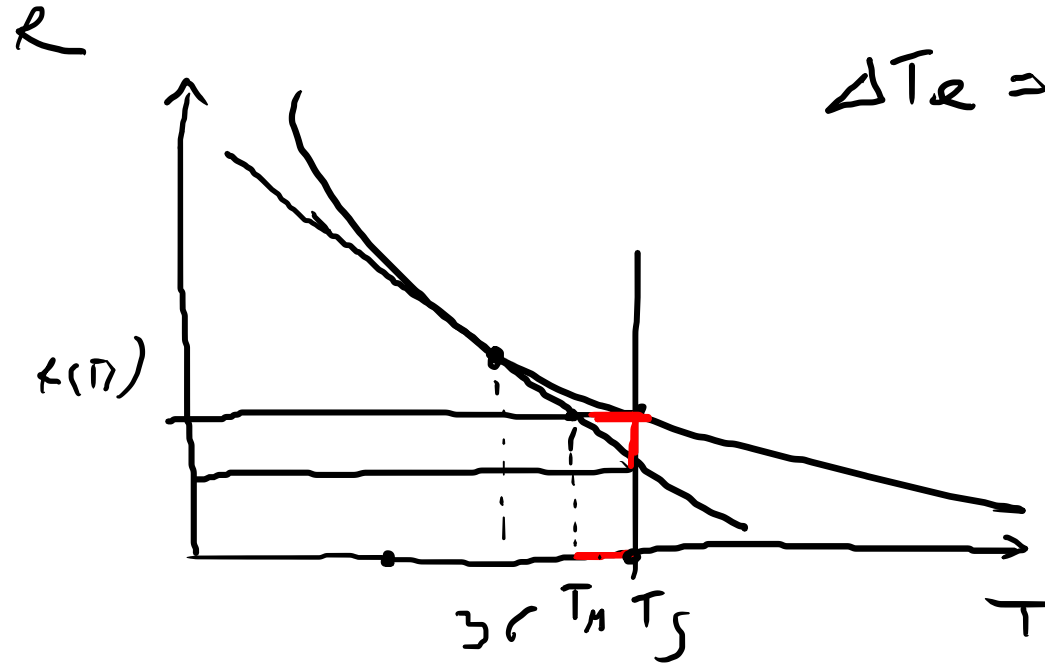
$$\text{ERRORE} = |T_M - T_x| = 0.07^\circ\text{C}$$

METODO
ALTERNATIVO \longrightarrow

CALCOLO ERRORE DI NON LINEARITÀ
ALLA T_s E CALCOLO T_M CON

$$T_s - |\Delta T_e| \quad \longrightarrow \quad \downarrow$$

$T_M \rightarrow$



$$\Delta T_e = \frac{\Delta R}{S_R} = \frac{|\Delta R|}{|\bar{R}|}$$

$$\Delta R = R(T_S) - R_L(T_S)$$

$$\Delta T_e = \frac{|R_L(T_S) - R(T_S)|}{|\bar{R}|} = 0.25^\circ\text{C}$$

$$T_M = T_S - \Delta T_e = 38.93^\circ\text{C} \quad \text{ERROR} = |T_M - T_x| = 0.07^\circ\text{C}$$