Esercitazione 10

Esercizio 8 (Esercitazione 9)

$s = 0{,}07\,m$

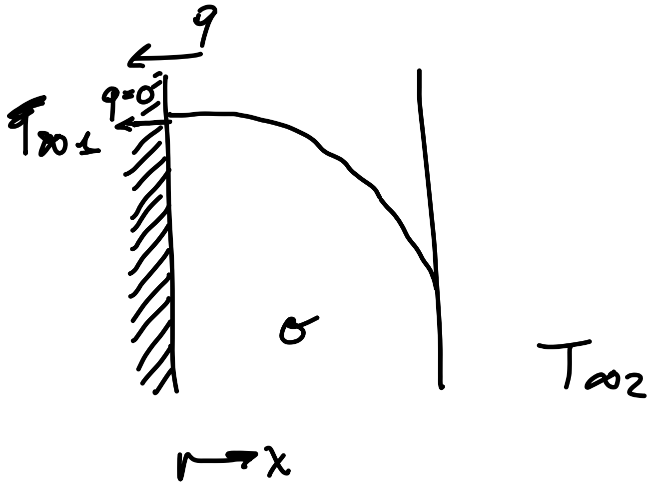
$k = \frac{20\,W}{mK}$

$T_{\infty 1} = 673{,}15\,K$

$T_{\infty 2} = 293{,}15\,K$

$h = 10\,\frac{W}{m^2 K}$

? σ affinché $q=0$



$$\frac{d^2T}{dx^2} = \frac{-\sigma}{k}$$

$$\frac{dT}{dx} = \frac{-\sigma}{k}x + c_1$$

$$q(x) = -k\frac{dT}{dx} = \sigma x - kc_1$$

$$T(x) = \frac{-\sigma}{k}\frac{x^2}{2} + c_1 x + c_2$$

$$q(0) = 0$$

$$0 = -kc_1 \rightarrow c_1 = 0$$

$$q(x) = \sigma x$$

$$T(x) = \frac{-\sigma}{k}\frac{x^2}{2} + C_2$$

$$q(s) = h(T_2 - T_\infty)$$

$$\dot{q}(x) = \frac{\Delta T}{R} \qquad \dot{q}'' = \frac{\dot{q}}{A} \qquad R_{cv} = \frac{1}{hA}$$

$$\sigma s = h\left[\left(\underbrace{\frac{-\sigma}{k}\frac{s^2}{2} + C_2}_{T_2 = T(s)} - T_\infty\right)\right]$$

$$C_2 = \frac{\sigma}{h}s + \frac{\sigma}{2k}s^2 + T_{\infty 2}$$

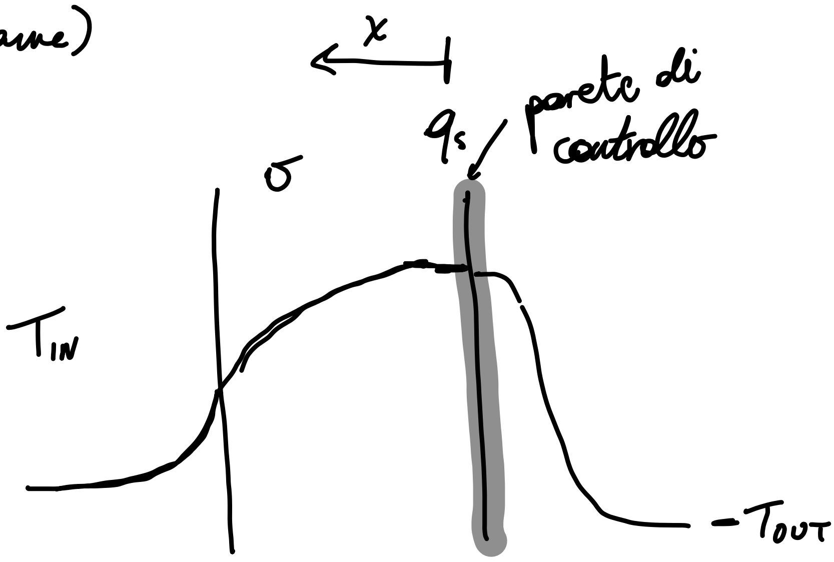
$$\sigma \cdot T_{\infty 1} = \frac{\sigma}{h}s + \frac{\sigma}{2k}s^2 + T_{\infty 2}$$

$$T(0) = T_1 = T_{\infty 1} \rightarrow C_2 = T_{\infty 2}$$

Non sapamo σ quindi lo abbiamo dovuto trovare con condizioni di contorno:

$$\sigma = \frac{T_{\infty 1} - T_{\infty 2}}{\frac{s}{h} + \frac{s^2}{2k}} = 53352 \ \frac{W}{m^3}$$

Esercizio 2 (Tema d'Esame)



$s = 0{,}2\,m$

$k = 4\ \frac{W}{mK}$

$\sigma = 1000\ \frac{W}{m^3}$

$h_{IN} = \frac{20}{m^2 K}$

$h_{OUT} = 5\ \frac{W}{m^2 K}$

$T_{IN} = 323{,}15\,K$

$T_{OUT} = 298{,}15\,K$

1. Profilo T
2. T_{pIN}, T_{pOUT}
3. q_s

$$T(x) = \frac{-\sigma}{k}\frac{x^2}{2} + c_1 x + c_2$$

$$q(x) = \sigma x - k c_1$$

$$q(0) = 0 \Rightarrow c_1 = 0$$

$$T(x) = \frac{-\sigma}{k}\frac{x^2}{2} + c_2$$

$$q(x) = \sigma x$$

$$q(s) = h_{IN}(T_{pin} - T_{pout})$$

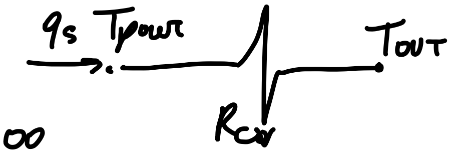
$$\rightarrow \sigma s = h_{IN}\left[\frac{-\sigma}{k}\cdot\frac{s^2}{2} + c_2\right) - T_{IN}$$

$$T(x) = \frac{-\sigma}{2k}(x^2 - s^2) + \frac{\sigma s}{h_{IN}} + T_{IN}$$

$$T_{pOUT} = T(0) = \frac{\sigma}{2k} \cdot s^2 + \frac{\sigma s}{h_{IN}} + T_{IN} = 65°C$$

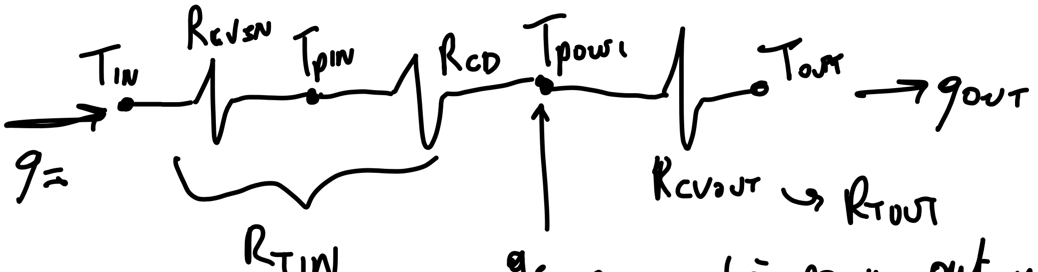
$$T_{pIN} = T(s) = \frac{\sigma s}{h_{IN}} + T_{IN} = 60°$$

$$q_s = h_{OUT}\left(T_{pOUT} - T_{OUT}\right) = \frac{200}{m}$$



Cosa succederebbe a questa

La parete pere se non era adiabatica ma la trattavamo in quel modo grazie a σ



q_s ↝ un pò va in out un pò in IN, dipendendo alle resistenze

$$q_s = q_{SN} + q_{OUT} = \frac{T_{pOUT} - T_{IN}}{R_T} + h_{OUT}\left(T_{po} - T_{pOUT}\right)$$

$$q_s = \left(\frac{1}{R_{TIN}} + h_{OUT}\right) T_{pOUT} - \frac{T_{IN}}{R_{TIN}} - h_{OUT}\, T_{OUT}$$

$$T_{pout} = \frac{q_s + \frac{T_{in}}{T_{out}} + h_{out} \cdot T_{out}}{\frac{1}{R_{tin}} + h_{out}} = 55°C$$

Esercizio 1.1

$D = 0,2\,m$

$k = 0,5\,\frac{W}{mK}$

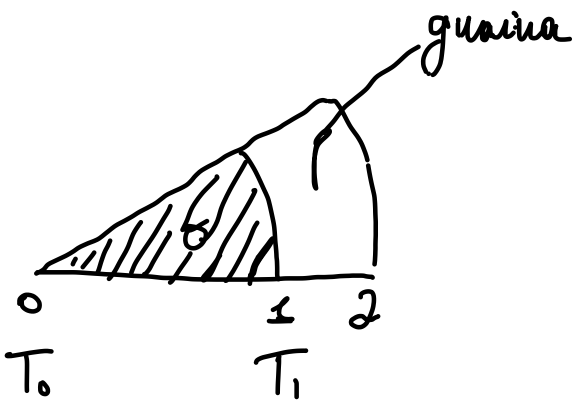
$\sigma = 24000\,\frac{W}{m^3}$

$s = 0,1\,m$

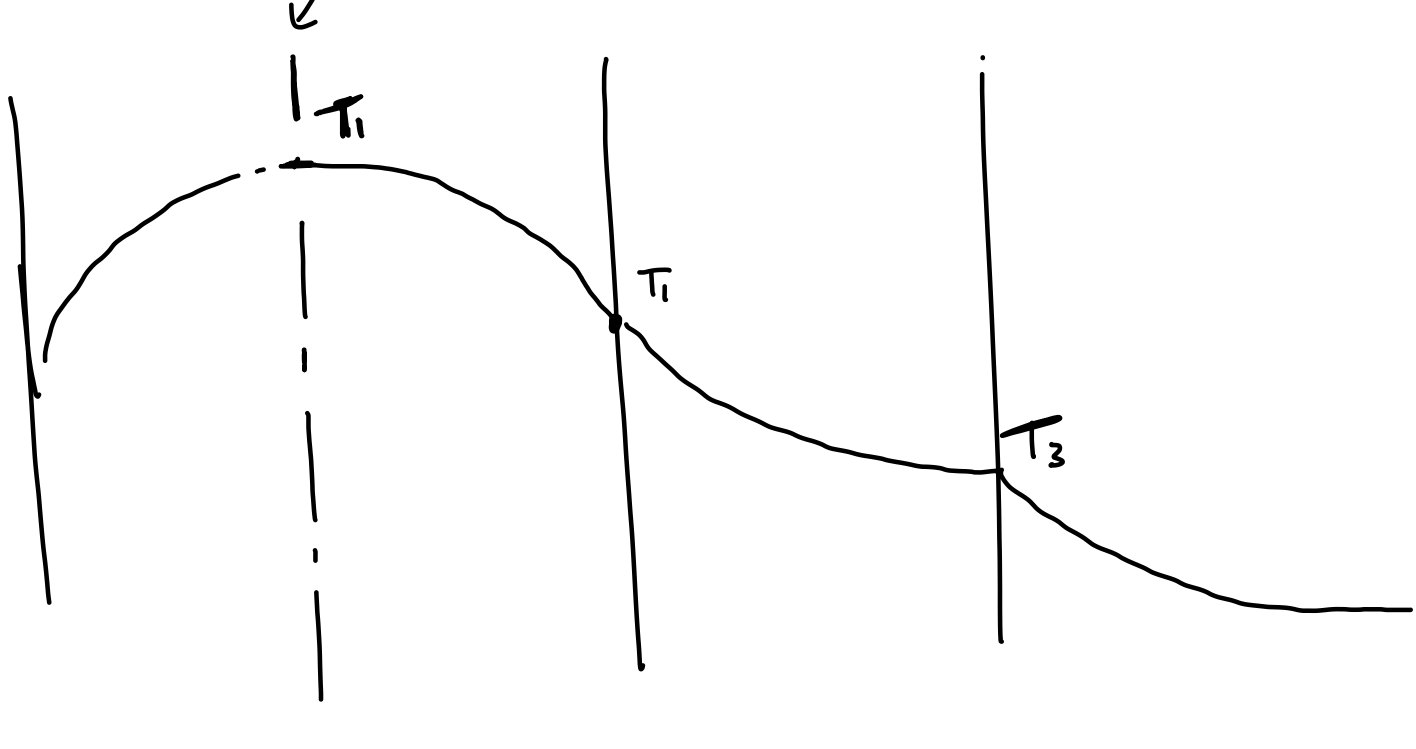
$k_g = \frac{4W}{mK}$

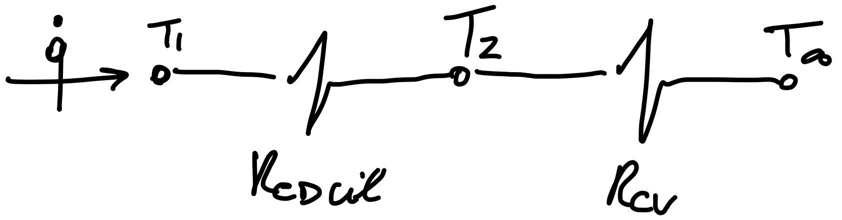
$T_\infty = 27°C = 300°K$

$h = 25\,\frac{W}{m^2K}$



Simmetrico ma consideriamo solo un lato





[W]

$\dot q$ e σ sono connesse in questo caso

$$\frac{\dot q}{L} = \sigma \pi \frac{D^2}{4} = 754 \ \frac{W}{m}$$

$$R_{TOT} = R_{CD} + R_{CV} = \frac{\ln \frac{r_2}{r_1}}{2\pi k_g} + \frac{1}{h \cdot 2\pi r_2} = 5,941 \cdot 10^{-2} \ \frac{mK}{W}$$

Abbiamo tolto la L perché usiamo $\dot q'$

$$\dot q = \frac{T_1 - T_\infty}{R_{TOT}} \Rightarrow T_1 = 71,8\,°C$$

$$\frac{1}{r} \frac{d}{dr}\left(r \frac{dT}{dr}\right) + \frac{\sigma}{k} = 0$$

$$\frac{dT}{dr} = \frac{-\sigma}{k} \cdot \frac{r}{2} + \frac{c_1}{r} \rightarrow q(r) = -k\left(\frac{dT}{dr}\right) = \frac{\sigma r}{2} - \frac{k c_1}{r}$$

$$T(r) = \frac{\sigma r^2}{4k} + c_1 \ln(r) + c_2$$

$$\frac{\sigma r}{2} - \frac{k c_1}{r} = 0 \qquad \frac{\sigma r^2}{2} - k c_1 = 0 \Rightarrow c_1 = 0$$

$$T(r) = \frac{-\sigma}{4k} r^2 + c_2$$

$$q(r) = \frac{\sigma r}{2}$$

$$T(r_1) = T_1 \rightarrow \frac{-\sigma}{4k} r_1^2 + c_2 = T_1$$

$$c_2 = T_1 + \frac{\sigma}{4k} r_1^2$$

$$\boxed{T(r) = \frac{\sigma}{4k}(r_1^2 - r_2^2) + T_1}$$

$$T(0) = 192°C$$

Esercizio #4

$T_\infty = 30°C = 303{,}75 K$

$\rho_{H_2O} = 998 \frac{kg}{m^3}$

$D = 0{,}005 \, m$

$\mu_{H_2O} = 8{,}3 \times 10^{-4} \frac{kg}{ms}$

$T_0 = 200°C = 473{,}75 K$ TINIZIALE

$k_{H_2O} = 0{,}265 \frac{W}{mK}$

$h = 1000 \frac{W}{m^2 K}$

$c = 4{,}18 \frac{kJ}{kgK}$ $\rho_{bronzo} = 8800 \frac{kg}{m^3}$

$k_b = 52 \frac{W}{mK}$

$c_b = 0{,}42 \frac{kJ}{kgK}$

$$\boxed{?\, t_{min} \quad T_1 - T_\infty < 1{,}5°C}$$

Posso usare il metodo dei parametri concentrati?

Biot

$$Bi = \frac{hL_c}{k} \quad k \to \text{solido}$$

$$\boxed{L_c = \frac{\text{Volume corpo}}{\text{Area Bagnata}}} = \frac{4/3 \pi R^3}{4\pi R^2} = \frac{R}{3} = \frac{D}{6}$$

se $Bi < 0{,}1$ posso usare metodo dei parametri concentrati

$$Bi = \frac{1000 \cdot 0{,}000083 \text{ m}}{52} = 0{,}0016 < 0{,}1$$ posso usare parametri concentrati

$$\dot{q}^{\leftarrow} = -hA(T - T_\infty)$$

$$\dot{q}^{\leftarrow} = \frac{dU}{dt} = Mc\frac{dT}{dt}$$

$$Mc\frac{dT}{dt} = -hA(T - T_\infty)$$

$$\frac{dT}{dt} = \frac{hA}{Mc}(T - T_\infty)$$

$$\frac{dT}{(T - T_\infty)} = -\frac{hA}{Mc}dt \qquad \int_{T_{in}}^{T_{fin}} \frac{dT}{T - T_\infty} = \int_{t_{in}}^{t_{fin}} -\frac{hA}{Mc}dt$$

$$T_{fin} = 30°C + 1{,}5°C = 304{,}65K$$

$$T_{IN} = 473{,}75K$$

$$\Big[h(T - T_\infty)\Big]_{T_{in}}^{T_{fin}} = \left[-\frac{hA}{Mc} \cdot A\right]_0^{t_{fin}}$$

$$\ln \frac{T_{fin} - T_\infty}{T_{in} - T_\infty} = -\frac{hA}{Mc}\, t_{fin}$$

$$\boxed{t_{fin} = -\frac{Mc}{hA} \ln\left(\frac{T_{fin} - T_\infty}{T_{in} - T_\infty}\right)} = 14{,}575$$

$$M_{fin} = \rho_b V_b = 0{,}02058 \text{ kg}$$