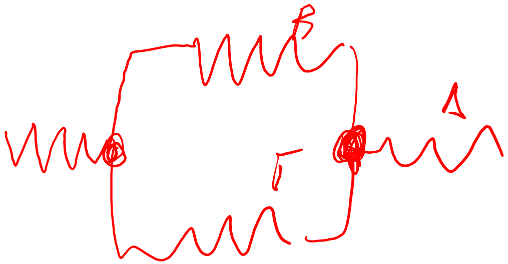


$$R_B = \frac{L}{k_B \cdot A_B}$$

$$R_\Gamma = \frac{L}{k_\Gamma A_\Gamma}$$

$$\dot{q}_{cond} = -k \cdot A \cdot \frac{\Delta T}{L}$$

$$\dot{q}_B = k_B \cdot A_B \cdot \frac{T_{AB\Gamma} - (T_{B\Gamma\Delta})_B}{L}$$

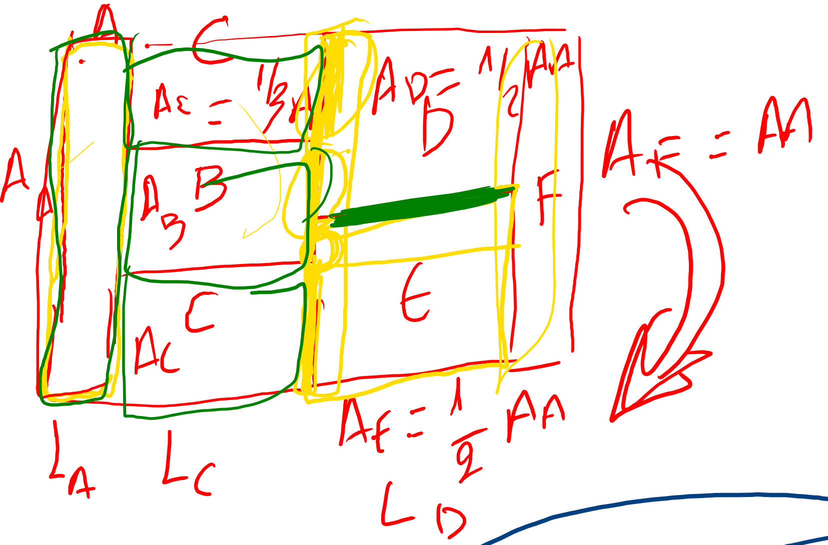
$$\dot{q}_\Gamma = k_\Gamma \cdot A_\Gamma \cdot \frac{T_{AB\Gamma} - (T_{B\Gamma\Delta})_\Gamma}{L}$$

$$\frac{\dot{q}_B}{\dot{q}_\Gamma} = \frac{k_B A_B}{k_\Gamma \cdot A_\Gamma}$$

$$\dot{q}_B + \dot{q}_\Gamma = \dot{q}_A$$

$$\dot{q}_A = k_A \cdot A \, \frac{T_1 - T_{AB\Gamma}}{L_A}$$

$$A = A_B + A_\Gamma$$



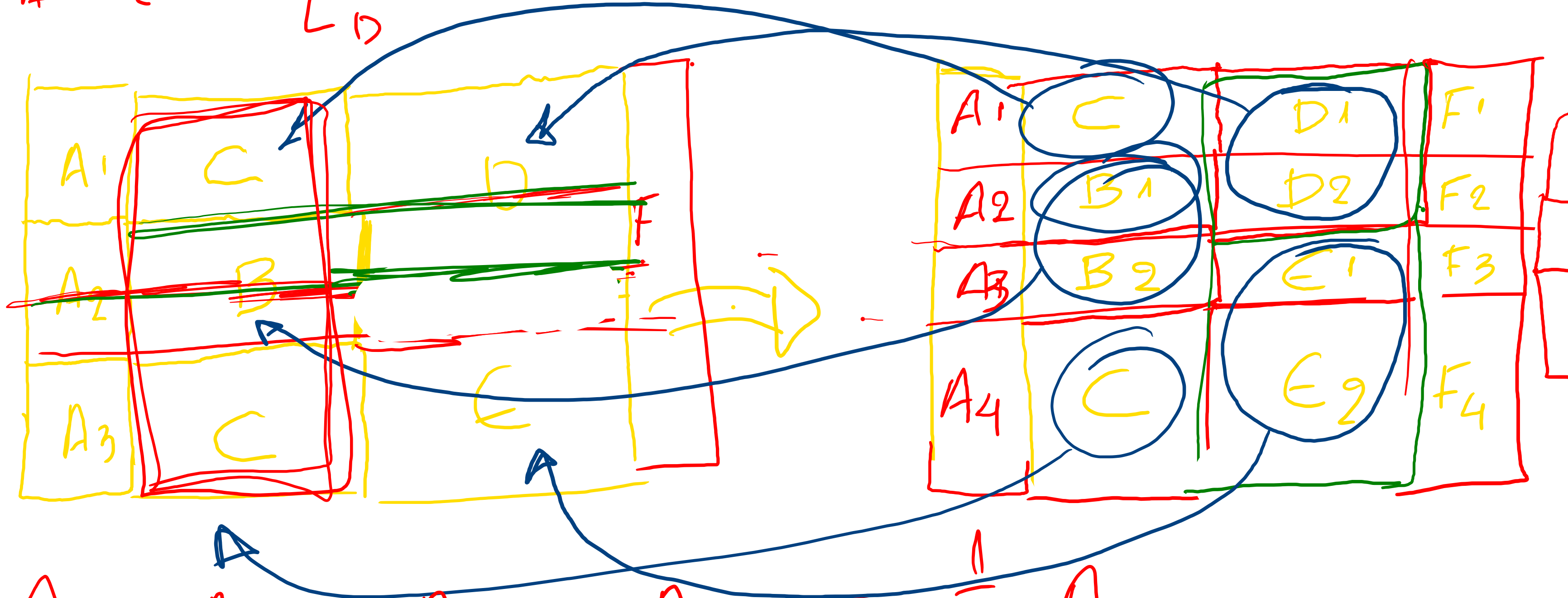
$$R = \frac{L}{k \cdot A}$$

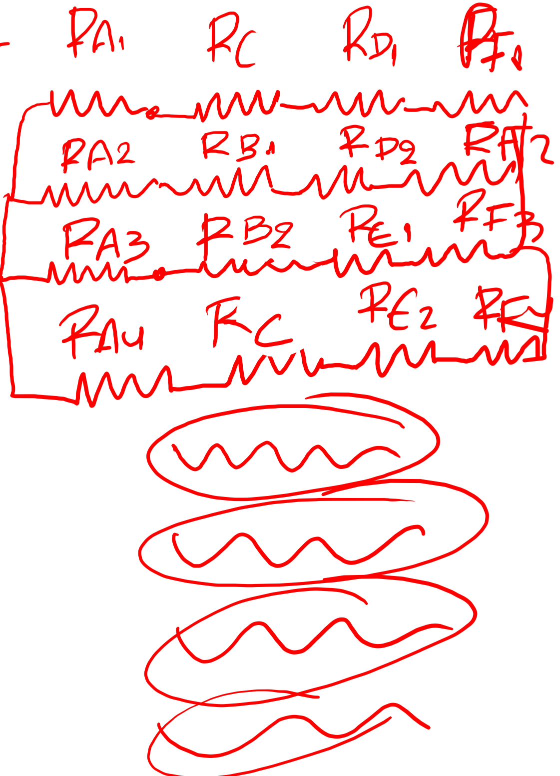
$$A_1 = \frac{1}{3}A$$

$$A_2 = \frac{1}{6}A$$

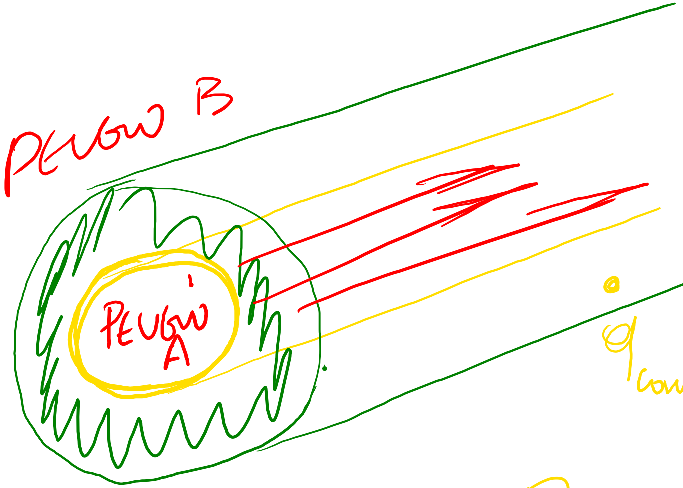
$$A_3 = \frac{1}{6}A$$

$$A_4 = \frac{1}{3}A$$





$$A_C = A_1 = A_{D_1} = A_{F_1} = \frac{1}{3}A$$



$$\dot q_{conv,1} = \frac{T_{\infty,1} - T_1}{R_{conv,1}}$$

$$R_{total} = R_{conv,1} + R_{cond} + R_{conv,2}$$

$$R_{conv,1} = \frac{1}{h_1 \cdot A_1} = \frac{1}{h_1 \cdot 2\pi \cdot r_1 \cdot L}$$

$$R_{cond} = \frac{\ln(r_2/r_1)}{2\pi k L}, \quad R_{conv,2} = \frac{1}{h_2 2\pi r_2 L}$$

$$\dot q_{total} = \frac{T_{\infty,1} - T_{\infty,2}}{R_{total}}$$

$$\dot q_{total} = \dot q_{conv,1} = \dot q_{cond} = \dot q_{conv,2}$$

$$\dot{q}_{conv,1} = \frac{T_{\infty,1} - T_1}{R_{conv,1}} \Rightarrow T_{\infty,1} - T_1 = \dot{q}_{conv,1} R_{conv,1}$$

$$\dot{q}_{cond} = \frac{T_1 - T_2}{R_{cond}} \Rightarrow T_1 - T_2 = \dot{q}_{cond} \cdot R_{cond}$$

$$\dot{q}_{conv_2} = \frac{T_2 - T_{\infty,2}}{R_{conv_2}} \Rightarrow T_2 - T_{\infty,2} = \dot{q}_{conv_2} \cdot R_{conv,2}$$

$$T_{\infty,1} - T_{\infty,2} = \dot{q}_{total} \cdot (R_{conv_1} + R_{cond} + R_{conv})$$

$$R_{total}.$$

$$\dot{q}_{total} = \frac{T_{\infty,1} - T_{\infty,2}}{R_{total}}$$

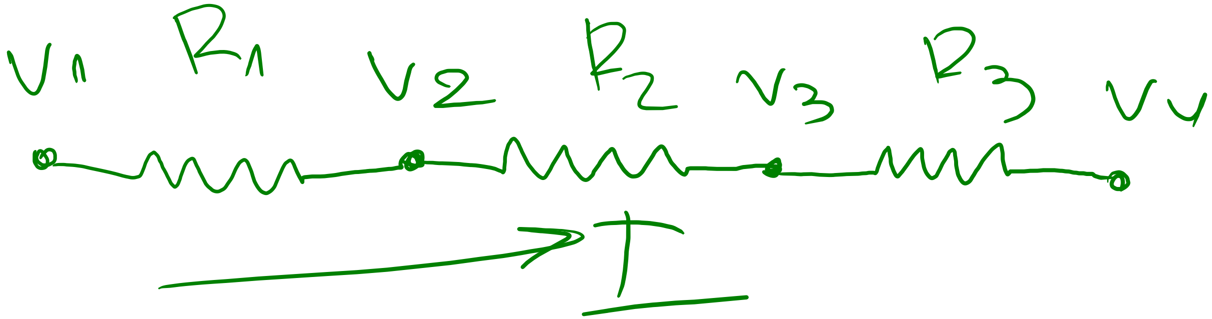
$$I_1 = \frac{V_1 - V_2}{R_1} \Rightarrow$$

$$I_2 = \frac{V_2 - V_3}{R_2} \Rightarrow$$

$$I_3 = \frac{V_3 - V_4}{R_3} \Rightarrow$$

$$\left.\begin{aligned} V_1 - \cancel{V_2} &= I_1 \cdot R_1 \\ \cancel{V_2} - \cancel{V_3} &= I_2 \cdot R_2 \\ \cancel{V_3} - V_4 &= I_3 \cdot R_3 \end{aligned}\right\}$$

$$V_1 - V_4 = I \cdot \underbrace{(R_1 + R_2 + R_3)}_{R_{tot}}$$



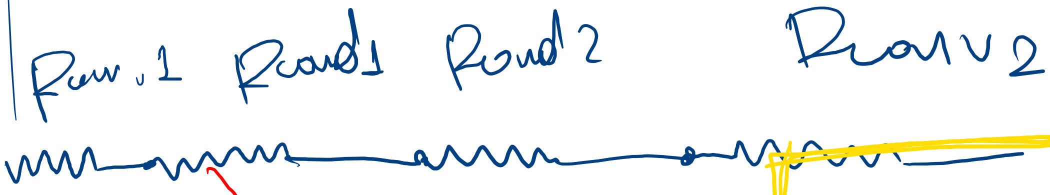
$0 \le r \le r_1$: Ρευστό

$r_1 \le r \le r_2$: Υλικό του σωλήνα.

$r_2 \le r \le r_3$: θερμική μόνωση

$T_{\infty,1} = T_1 = T_2$

$T_{\infty,2}$



$$R_{total} = R_{conv1} + R_{cond1} + R_{cond2} + R_{conv2} =$$

$$= \frac{1}{h_1 \cdot 2\pi r_1 L} + \frac{\ln r_2/r_1}{2 k_A \pi L} + \frac{\ln r_3/r_2}{2 k_B \pi L} + \frac{1}{h_2 2\pi r_3 L}$$

$$q_{total} = \frac{T_{\infty,1} - T_{\infty,2}}{R_{total}}$$

$\rightarrow R_{cond_2} + R_{conv,2}$

$$\dot{q}_{total} = \frac{T_{\infty,1} - T_{\infty,2}}{R_{total}}$$

$$R_{total} = R_{cond} + R_{conv\,2} = \frac{\ln r/r_1}{2k\pi L} + \frac{1}{h\,2\pi r L}$$

$$\dot{q}_{tot} = (T_{\infty,1} - T_{\infty,2}) \cdot \left[\frac{1}{\frac{\ln r/r_1}{2k\pi L} + \frac{1}{h\,2\pi r L}} \right] =$$

$$= (T_{\infty,1} - T_{\infty,2}) \left[\frac{2\pi L}{\frac{\ln r/r_1}{k} + \frac{1}{h \cdot r}} \right] \Rightarrow$$

$$\Rightarrow \dot{q}_{total} = 2\pi L \cdot (T_{\infty,1} - T_{\infty,2}) \cdot \left[\frac{1}{\frac{\ln r/r_1}{k} + \frac{1}{hr}} \right] = \dot{q}(r)$$