L3 Génie des matériaux — Corrigé type — 2021-2022

Exercice n° 01 : (08 pts)

1- L'équation générale de la conduction

$$\rho c_p \cdot \frac{\partial T}{\partial t} = \mathrm{div}\left[\lambda\, \overrightarrow{\mathrm{grad}}\, T\right] + \dot{q}_s \quad (1)$$

2- L'expression du profil de température

$$\rho c_p \frac{\partial T}{\partial t} = \mathrm{div}\left[\lambda \cdot \overrightarrow{\mathrm{grad}}\, T\right] + \dot{q}_s$$

- le régime est stationnaire $\frac{\partial T}{\partial t} = 0$ (0,5)
- sans source $\dot{q}_s = 0$
- $\lambda = c^{te}$ (0,5)

$$\Rightarrow \frac{\partial^2 T}{\partial x^2} = 0 \Rightarrow \frac{\partial T}{\partial x} = A$$

$$\Rightarrow \boxed{T(x) = A.x + B} \quad (1)$$

on calcule A et B à partir des conditions aux limites (0,5)

à $x = 0$, $T = T_1$

$T_1 = A(0) + B \Rightarrow \boxed{B = T_1 = 30}$

à $x = 0{,}2\,m$; $T = T_2$

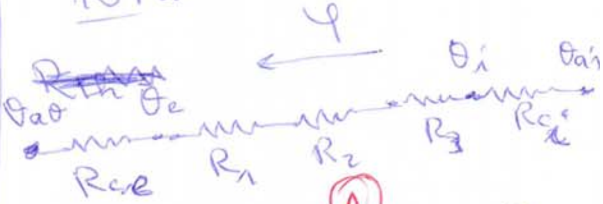
$T_2 = A.(e) + B \Rightarrow A = \frac{T_2 - B}{e}$

$A = \frac{15 - 30}{0{,}2} = -75$ (0,5)

$$\boxed{T(x) = -75x + 30} \quad (1)$$

Exercice n° 02 (07 pts)

1) - La résistance thermique totale



(1)

$$R_{th} = R_{ce} + R_1 + R_2 + R_3 + R_{ci}$$

$$R_1 = \frac{e_1}{\lambda_1 S} = \frac{15.10^{-2}}{0{,}23(1)} = 0{,}652\,K/W$$

$$R_2 = \frac{e_2}{\lambda_2 S} = \frac{5.10^{-2}}{0{,}035(1)} = 1{,}428\,K/W$$

$$R_3 = \frac{e_3}{\lambda_3 S} = \frac{5.10^{-2}}{0{,}47(1)} = 0{,}106\,K/W$$

(2,5)

$$R_{ci} = \frac{1}{h_i S} = \frac{1}{h_i} = 0{,}11\,K/W$$

$$R_{ce} = \frac{1}{h_e S} = \frac{1}{h_e} = 0{,}06\,K/W$$

$$\boxed{R_{th} = 2{,}356\,K/W} \quad (0,5)$$

2) - Le flux thermique

$$\varphi = \frac{\theta_i - \theta_e}{R_{th}} \quad (1)$$

$$\varphi = \frac{25 - (-8)}{2{,}356} = \boxed{14\,W}$$

$$\boxed{\varphi = 14\,W}$$

Exercice n° 03 : (08 pts)

$D_3 = D_2 + 2e$

$D_3 = 5{,}5 + ($

$D_3 = 11{,}5\,cm$

$$R_{th} = R_{c1} + R_1 + R_2 + R_{c2} \quad (1)$$

(0,5)

$$R_{c1} = \frac{1}{h_1 S_1} = \frac{1}{h_1(\pi D_1 \cdot L)} = \frac{1}{60 \cdot (\pi \cdot 5 \cdot 10^{-2})(1)} = 0{,}106\ K/W$$

$$R_{c2} = \frac{1}{h_2 \cdot S_2'} = \frac{1}{h_2(\pi \cdot D_2 \cdot L)} = \frac{1}{18(\pi \cdot 5{,}5 \cdot 10^{-2})(1)} = 0{,}321\ K/W$$

$$R_1 = \frac{\ln D_2/D_1}{2\pi \lambda_1 \cdot L} = \frac{\ln(5{,}5/5)}{2\pi\, 80 \cdot (1)} = 0{,}000189\ K/W$$

(2)

$$R_2 = \frac{\ln(D_3/D_2)}{2\pi \cdot \lambda_2 \cdot L} = \frac{\ln(11{,}5/5{,}5)}{2\pi(0{,}05)(1)} = 2{,}3487\ K/W$$

$R_{th} = 2{,}775\ K/W$ (0,5)

2) + Le flux de chaleur perdu

$$\varphi = \frac{T_{\infty 1} - T_{\infty 2}}{R_{th}} = \frac{320 - 5}{2{,}775} = \text{~~[illegible] W~~}$$

$\varphi = 113{,}51\,°C$

(1)

3) _ La température de l'interface

$$\varphi = \frac{T_{\infty 1} - T_1}{R_{c1}} = \frac{\text{~~320 - T1~~}}{0{,}106} \Rightarrow T_1 = T_{\infty 1} - R_{c1} \cdot \varphi$$

(1)

$$T_1 = 320 - 0{,}106\,(113{,}51) = 307{,}96\,°C$$

$$\varphi = \frac{T_1 - T_2}{R_1} \Rightarrow T_2 = T_1 - R_1 \cdot \varphi$$

(1)

$T_2 = 307{,}96 - (0{,}000189 \cdot 113{,}54)$

~~$T_2 = 315{,}27\,°C$~~

$T_2 = 307{,}93\,°C$

$$\varphi = \frac{T_2 - T_3}{R_2} \Rightarrow T_3 = T_2 - R_2 \cdot \varphi$$

~~$T_3 = 315,27 - 6,65 \cdot 89\ (44,96)$~~

~~$T_3 = 49,21\,°C$~~

(1) $T_3 = 307,95 - 2,3487 \cdot (113,51)$

$$\boxed{T_3 = 41,349\,°C}$$

3 - Les températures ambiantes extérieure et intérieure

$$\varphi = \frac{\theta_{ae} - \theta_e}{R_{ce}}$$

$$\Rightarrow \theta_{ae} = \theta_e + R_{ce} \cdot \varphi$$ (1)

$$\theta_{ae} = -8 + 0{,}06 \cdot 14$$

$$\boxed{\theta_{ae} = -7{,}16\ °C}$$

$$\varphi = \frac{\theta_i - \theta_{ai}}{R_{ci}}$$

$$\Rightarrow \theta_{ai} = \theta_i + R_{ci} \cdot \varphi$$ (1)

$$\theta_{ai} = 25 + 0{,}11 \cdot (14)$$

$$\boxed{\theta_{ai} = 26{,}54\ °C}$$