Heat transfer in buildings

Video n°1

Thermal-electrical analogy

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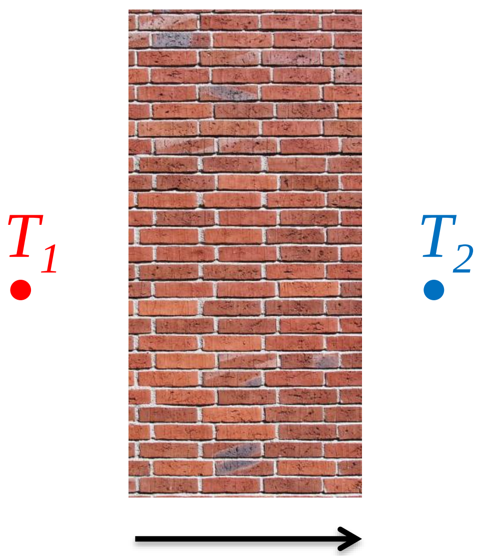
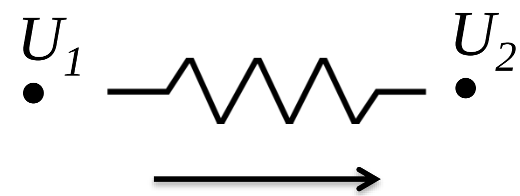


$$\varphi = \frac{\lambda}{e}(T_1 - T_2) = \frac{\Delta T}{R} \quad [\mathrm{W/m^2}]$$

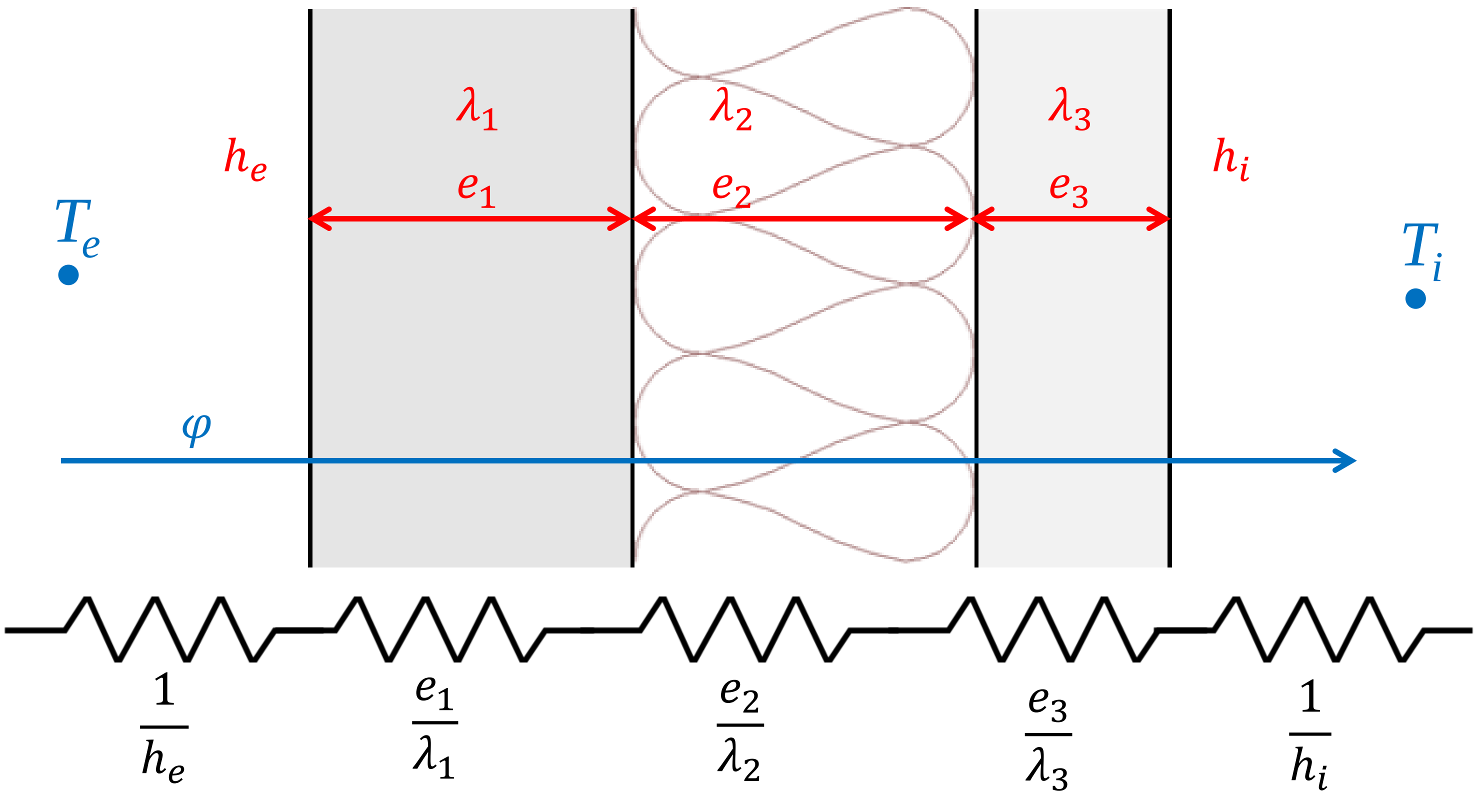
Electrical analogy



$$I = \frac{\Delta U}{R}$$

Temperature = Voltage
Heat flux = Current
$\Delta T = R\,\varphi$
$R = \frac{e}{\lambda}$ [m²K/W]

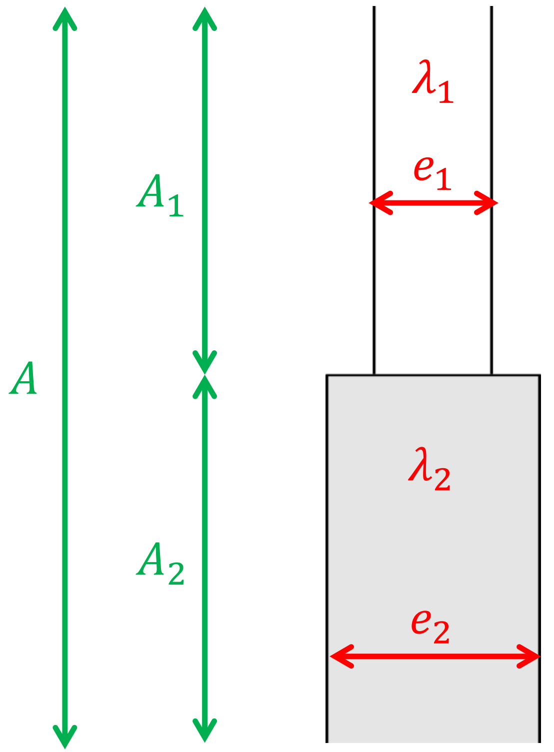
or $\varphi = U \Delta T$ with $U = \frac{1}{R}$ [W/m².K]

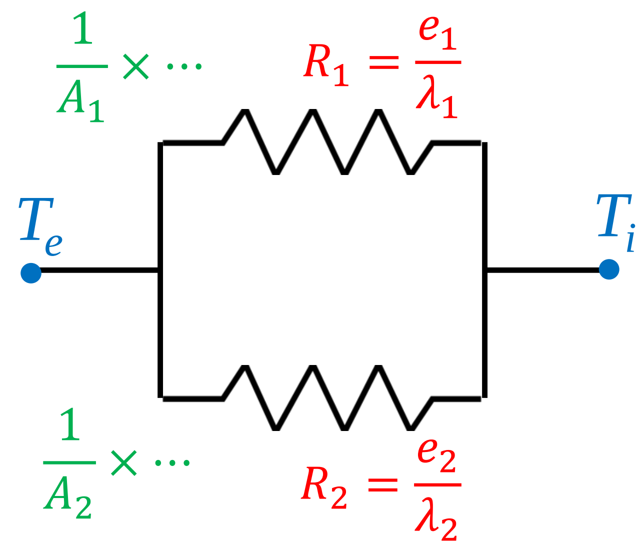


$\Delta T = R_{total} \times \varphi$ where $R_{total} = \frac{1}{h_e} + \frac{e_1}{\lambda_1} + \frac{e_2}{\lambda_2} + \frac{e_3}{\lambda_3} + \frac{1}{h_i}$

$\varphi = U \Delta T$ where $U = \frac{1}{R_{total}} = \frac{1}{\frac{1}{h_e}+\frac{e_1}{\lambda_1}+\frac{e_2}{\lambda_2}+\frac{e_3}{\lambda_3}+\frac{1}{h_i}}$

	Variable	Dimension	
T	Temperature	K	
λ	Conductivity	W/m.K	
h	Transfer coefficient	W/m^2.K	
R	Resistance	m^2.K/W	adds up in series
U	Transmittance	W/m^2.K	does not add up in series
φ	Heat flux	W/m^2	flow of energy per unit of area
ϕ	Total heat flux	W	total flow of energy





~~[W/m²] + [W/m²] = [W/m²]~~

[W] + [W] = [W]

$$\Phi = A.U.(T_e - T_i)$$

[W] [m²]

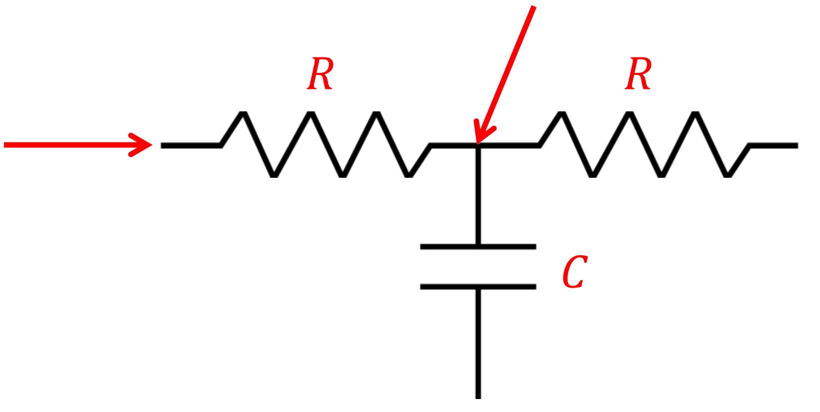
with

$$A.U = A_1U_1 + A_2U_2$$

$$U_1 = \frac{1}{R_1} = \frac{\lambda_1}{e_1}$$

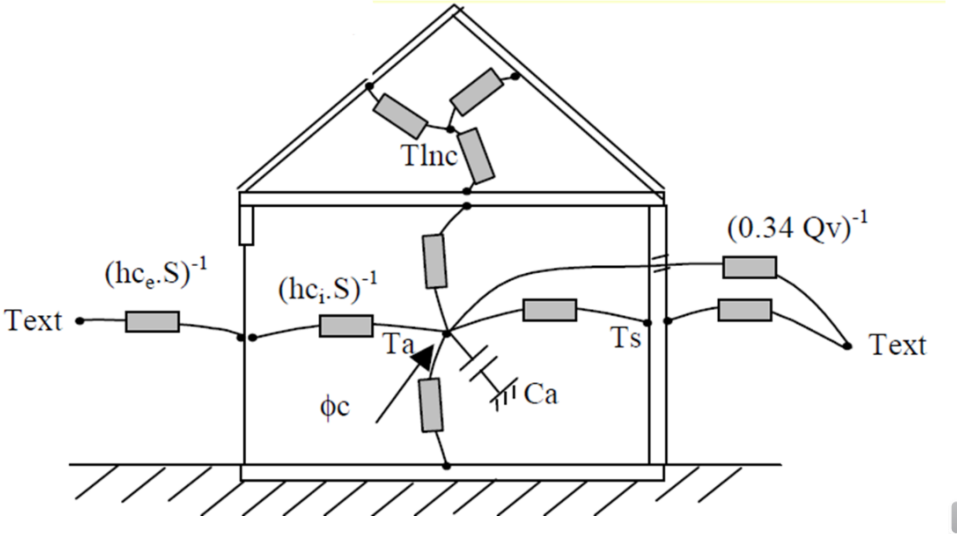
$$U_2 = \frac{1}{R_2} = \frac{\lambda_2}{e_2}$$

- Transient transfer

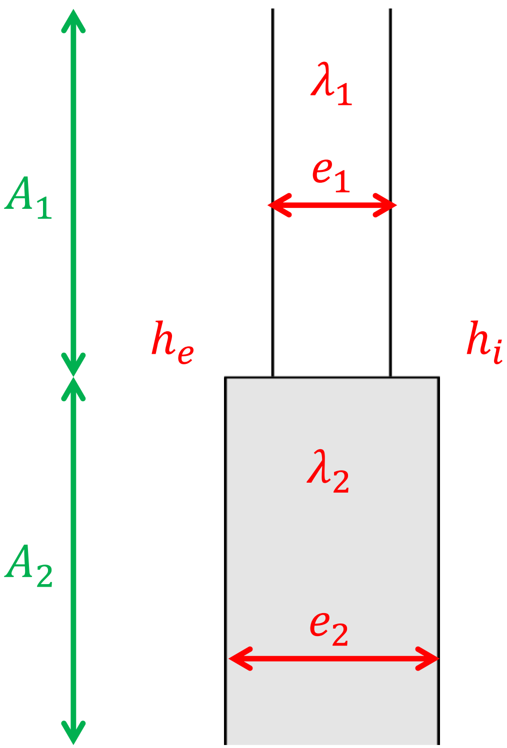


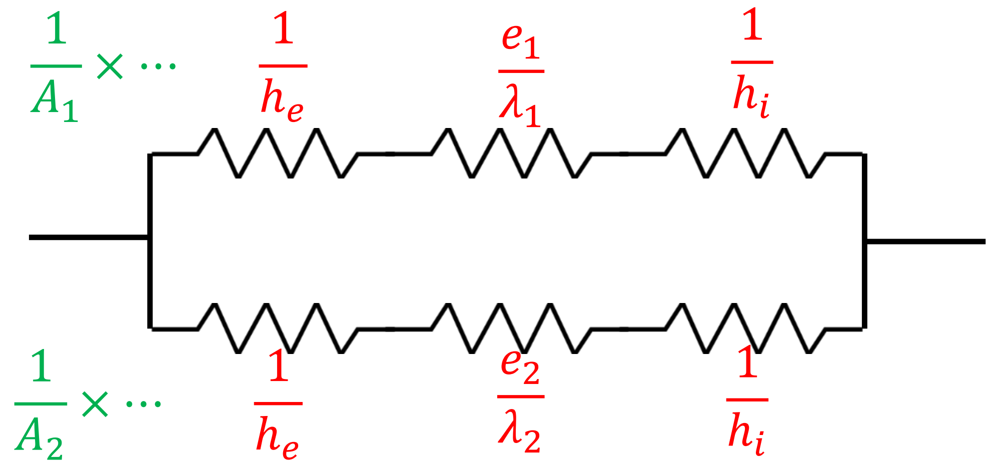
- Heat input

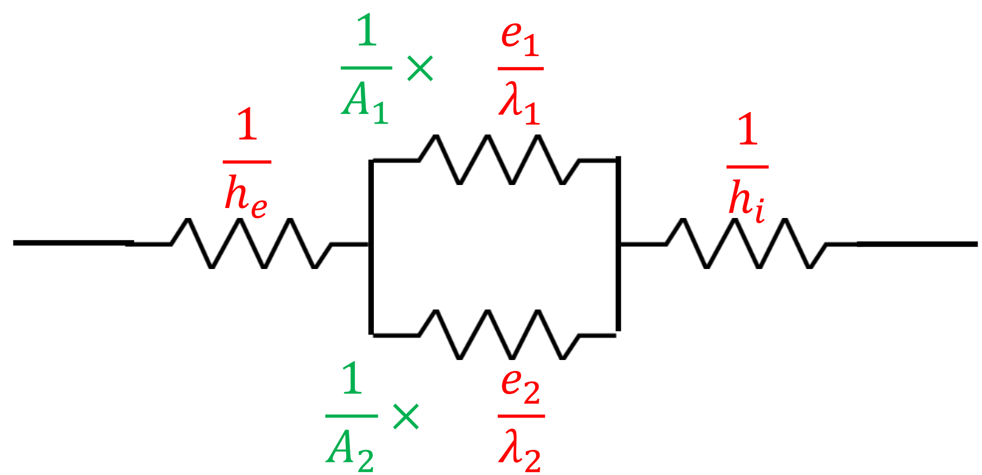
- Air transfer, convection, radiation...



Exercise


A_1
A_2
λ_1
e_1
h_e
h_i
λ_2
e_2


$\frac{1}{A_1} \times \cdots$
$\frac{1}{h_e}$
$\frac{e_1}{\lambda_1}$
$\frac{1}{h_i}$
$\frac{1}{A_2} \times \cdots$
$\frac{1}{h_e}$
$\frac{e_2}{\lambda_2}$
$\frac{1}{h_i}$


$\frac{1}{A_1} \times$
$\frac{e_1}{\lambda_1}$
$\frac{1}{h_e}$
$\frac{1}{h_i}$
$\frac{1}{A_2} \times$
$\frac{e_2}{\lambda_2}$