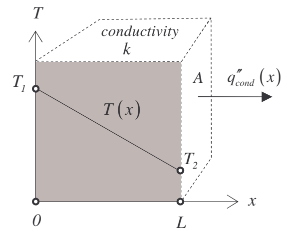
PLANE WALL

1-D STEADY STATE CONDUCTION *w/o heat generation* $(\dot{q} = 0)$



Heat Equation:

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

boundary conditions:

$$T(0) = T_1$$
$$T(L) = T_2$$

Solution of BVP:

$$T(x) = (T_2 - T_1)\frac{x}{L} + T_1$$

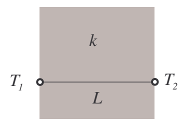
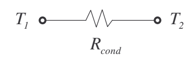
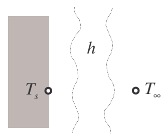
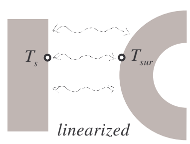
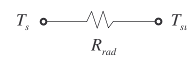
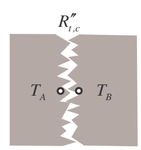
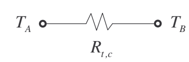
temperature gradient

$$\frac{\partial}{\partial x}T(x) = \frac{T_2 - T_1}{L}$$

rate of heat transfer

$$q = \frac{kA}{L}(T_1 - T_2) = \frac{T_1 - T_2}{R_{cond}}$$

Thermal Resistance

		resistance	*rate of heat transfer*	*thirmal circuit*
conduction		$R_{cond} = \frac{L}{kA}$	$q = \frac{T_1 - T_2}{R_{cond}}$	
convection		$R_{conv} = \frac{1}{hA}$	$q = \frac{T_s - T_\infty}{R_{conv}}$	
radiation	 linearized $h_r = \varepsilon\sigma(T_s + T_{sur})(T_s^2 + T_{sur}^2)$	$R_{rad} = \frac{1}{h_r A}$	$q = \frac{T_s - T_{sur}}{R_{rad}}$	
contact resistance		$R''_{t,c} = \frac{T_A - T_B}{q''_x}$	$q = \frac{T_A - T_B}{\frac{R''_{t,c}}{A}}$	

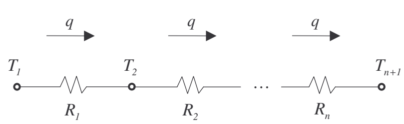
Thermal Curcuit

for plane system, q is the same for any layer between two temperatures

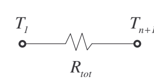
$$q = \frac{T_1 - T_{n+1}}{R_{tot}}$$

equivalent thermal circuit

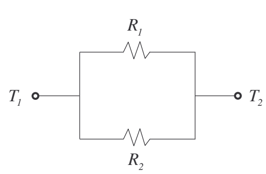
series



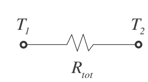
$$R_{tot} = R_1 + \ldots + R_n$$



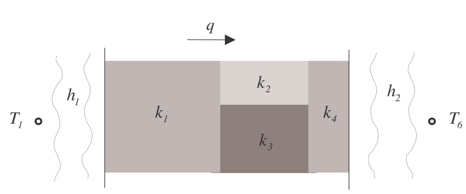
parallel



$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \ldots + \frac{1}{R_n}$$



Composite Wall



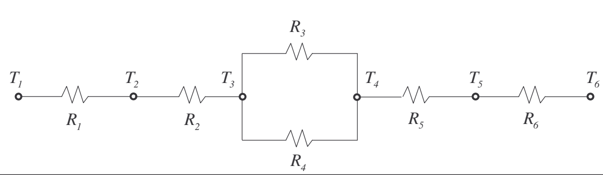
overall heat transfer coefficient

$$U = \frac{1}{A \cdot R_{tot}}$$

rate of heat transfer

$$q = U \cdot (T_1 - T_6) \cdot A$$

$$q = \frac{T_1 - T_6}{R_{tot}}$$



$$R_{tot} = R_1 + R_2 + \frac{1}{\frac{1}{R_3} + \frac{1}{R_4}} + R_5 + R_6$$