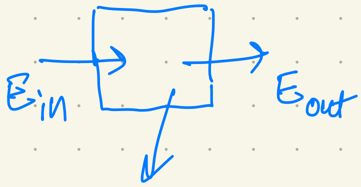
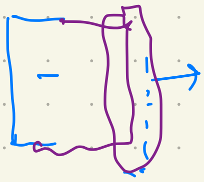
Week 1 → FLOT

$$E_{in} - E_{out} = \Delta E_{sys}$$



Should have some mass & some volume.

HT →

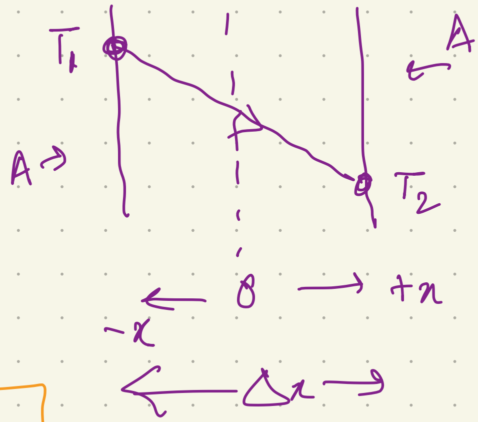


$$E_{in} = E_{out}$$

Heat Conduction

$$\dot{Q}_{cond} = -kA \frac{dT}{dx}.$$

$$\dot{Q}_{cond} = kA \frac{(T_1 - T_2)}{\Delta x}$$

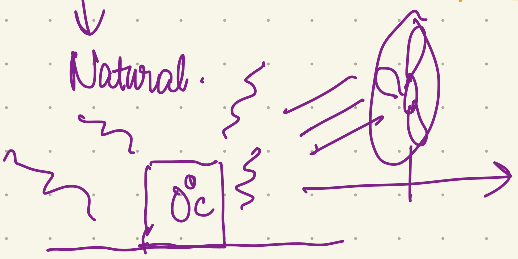


Convection → Forced

↓

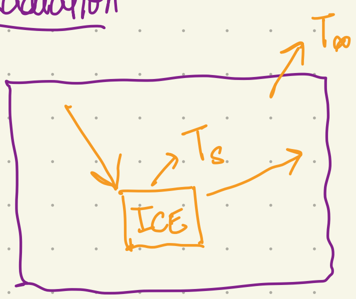
Natural.

$$\boxed{\dot{Q}_{conv.} = h \times A_x (\Delta T)}$$



→ Make the melting faster.

Radiation



Surface area of this ice

$$\dot{Q}_{rad} = \epsilon \sigma A_s \times (T_s^4 - T_\infty^4)$$

Conduction ← ① Solid Opaque Substance

Convection/Radiation ← ② Gas/Liquid

Radiation ← ③ Vacuum.

At max, there can be only 2 modes of heat transfer.

Week 2

$$3D \rightarrow \frac{1}{A}\frac{\partial}{\partial x}\left(kA\frac{\partial T}{\partial x}\right) + \underbrace{\dot{e}_{gen}}_{} = \rho C_p \frac{\partial T}{\partial t}$$

$$\dot{Q}_{cond} = -kA\frac{dT}{dx}.$$

System might be generating its own heat.

Transient Heat transfer → Significant

Steady State → No time dependence

No heat generation → Neglect $\dot{e}_{gen}$

$$3D \rightarrow \text{These 2 assumptions} \rightarrow \boxed{\frac{d^2T}{dx^2} = 0.}$$

Spherical Coordinates → $r\frac{d^2T}{dr^2} + 2\frac{dT}{dr} = 0$

Cylindrical Coordinates → $\frac{d}{dr}\left(r\frac{dT}{dr}\right) = 0$

Most General Form

→ No steady state

→ Heat Generation

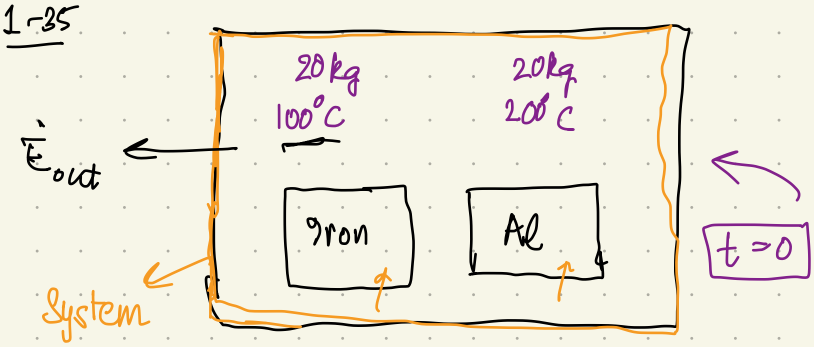
$$\boxed{\frac{1}{r^n}\frac{\partial}{\partial r}\left(r^n k\frac{\partial T}{\partial r}\right) + \dot{e}_{gen} = \rho C_p\frac{\partial T}{\partial t}}$$

$n \rightarrow 0$ 3D

$\rightarrow 1 \rightarrow$ cyl

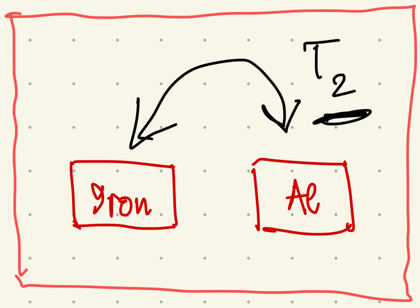
$\rightarrow 2 \rightarrow$ Spherical

1-35



$t=0$

after $t=\infty$



$C_{p,i} = 0.45$ kJ/kg°C

$C_{p,A} = 0.973$ kJ/kg°C

$$E_{in} - \cancel{E_{out}}^{0} = \cancel{\Delta E_{sys}}^{0}$$

$\boxed{E_{in} = 0}$ } $t=0$ & $t=\infty$

$t=0$ { Iron → $T_{Fe} = 100°C$; Al → $T_{Al} = 200°C$

$t=\infty$ { Iron → T_2; Al → T_2

$$\underbrace{\dot{m}_{Fe} C_{p_{Fe}} (\Delta T)_{Fe}}_{} + \underbrace{\dot{m}_{Al} C_{p_{Al}} (\Delta T)_{Al}}_{} = 0$$

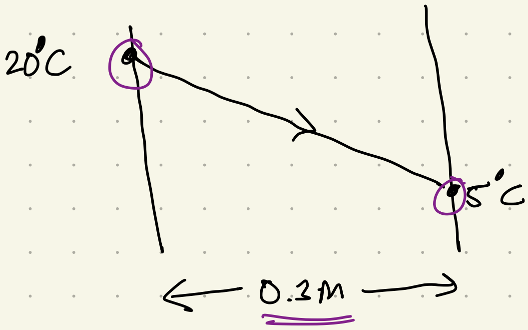
$$20 \times (0.45 \times 1000) \times (T_2 - 100^\circ C) + 20 \times (0.973 \times 1000) \times (T_2 - 200^\circ C) = 0$$

$$\boxed{T_2 = 168^\circ C}$$

1.62

$A_{wall} = A = 5 \times 6\ m^2 = 30\ m^2$

$k = 0.69\ W/m^\circ C \Leftrightarrow W/mK$



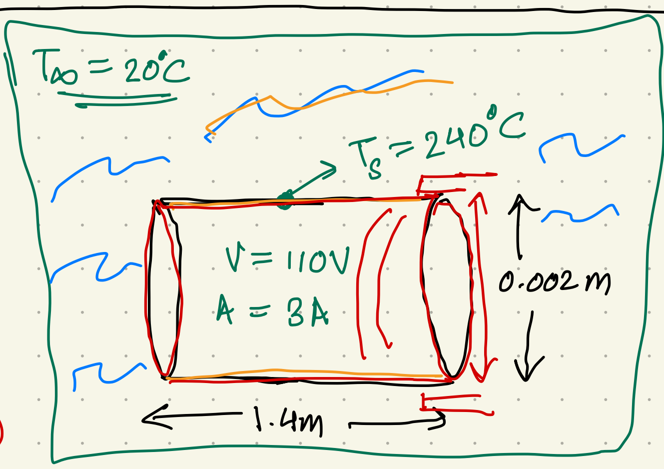
??. $\boxed{\dot{Q}} = kA \frac{\Delta T}{\Delta x}$ → $(20-5) = 15$

k → 0.69, A → 30, Δx → (0.3)

$$\dot{Q} = 0.69 \times 30 \times \left(\frac{15}{0.3}\right) \rightarrow \boxed{1035\ W}$$

Prob 1-102

$\dot{Q} = h \times A_s \times (\Delta T)$??



$A \times V$

$\dot{Q} = A \times V$

$\dot{Q} = 110 \times 3 = \boxed{330W}$

$\pi \times D \times L$ → $\pi \times 0.002 \times 1.4m$ → $A_s = 0.009 m^2$

$(T_s - T_\infty)$ → $(240-20)$ → 220 -

$$330W = h \times \underbrace{0.009}_{m^2} \times \underbrace{220}_{^\circ C} \Rightarrow h = 170.5\ (W/m^2K)\ (W/m^2\,^\circ C)$$

$(h \rightarrow W/m^2\,^\circ C)$

$W/m^2\,^\circ C$

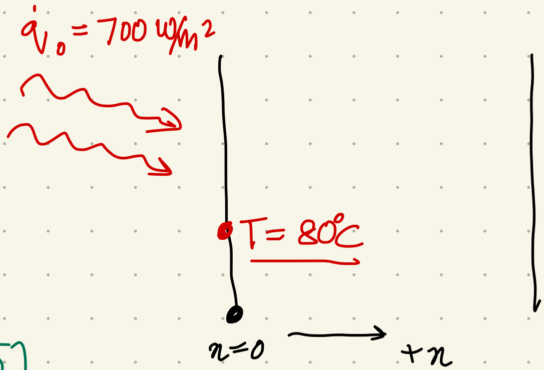
$k \rightarrow$

2.64

$L = 0.3m$ ✓

$k = 2.5\ W/m^\circ C$

$A_s = 12 m^2$



① → Assume Steady State. ⇒ Temporal Term vanishes.

② → Assume No Heat Generation ⇒ $\boxed{\dot{g} \rightarrow 0}$

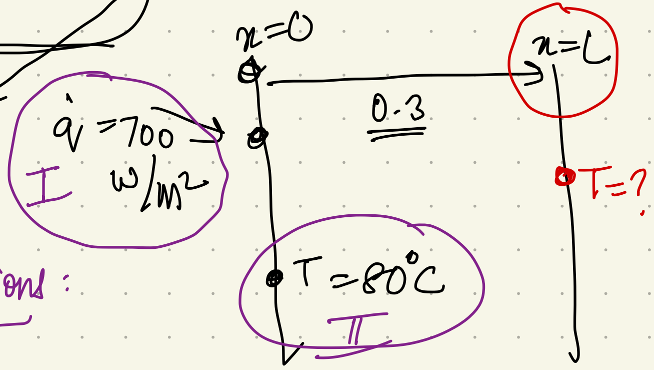
③ → Assume 1D Heat transfer.

1D fourier → Conduction → $\frac{d^2T}{dx^2} = 0$ → DE

$\int \frac{d^2T}{dx^2} = \int 0$

$\int \frac{dT}{dx} = \int C_1$

$\boxed{T = C_1 x + C_2}$



Boundary Conditions :

I → $\dot{Q} = -kA \frac{dT}{dx}$

$700 = -2.5 \times 12 \times \frac{dT}{dx}$

$\boxed{\frac{dT}{dx} = \frac{-700}{2.5 \times 12} \rightarrow A}$

$\frac{dT}{dx} = \boxed{-23.33 \text{ K/m}}$

II $\boxed{T_{x=0} \Rightarrow 80°C}$ $\quad T_{x=0}) \rightarrow 80°C$

$T = C_1 x + C_2$

$80 = C_1 \times 0 + C_2$

(b) $\boxed{C_2 = 80°C}$

$\frac{dT}{dx} = C_1 = -23.33$ K/m.

$\boxed{T = -23.33 \times x + 80}$

0.3

(c) $T = -23.33 \times 0.3 + 80 \rightarrow \boxed{73.001\ °C}$