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Homework not collected — 4 are review of differential equations in syllabus

Chapter 1 – Introduction

- 1.2.1 Conduction → Chapters 2 – 5
- 1.2.2 Convection (conduction + fluid motion) → Chapters 6 – 9
- 1.2.3 Radiation →

Ch. 2

Big equation $T(x,y,z,t)$

$$(2.19)\quad \frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right)+\frac{\partial}{\partial y}\left(k\frac{\partial T}{\partial y}\right)+\frac{\partial}{\partial z}\left(k\frac{\partial T}{\partial z}\right)+\dot{q}=\rho c_p\frac{\partial T}{\partial t}$$

Ch. 3: One dimensional, steady state

$T(x)$ or $T(r)$

Ch. 4: 2 dimensional, steady state

$T(x,y)$

Ch. 5: Transient

$T(t)$ or $T(x,t)$

Ch. 6: Intro to convection (dimensionless numbers) → other dimensionless groups

- Biot
- Fourier
- [illegible]
- Nusselt
- Prandtl
- Reynolds, $P_r = \left(\frac{\nu}{\alpha}\right)$

Ch. 7: External Flow

Ch. 8: Internal Flow

Ch. 9: Free convection (natural convection)

TD	HT	TD

closed system $\Delta E = Q - W$

open system $\dot{Q} - \dot{W} + \sum_{in} \dot{m}\left(h + \frac{V^2}{2} + gz\right) - \sum_{out} \dot{m}\left(h + \frac{V^2}{2} + gz\right)$

$\dot{Q}$

$q = \frac{Q}{A}$

$\dot{Q}$ — $\dot{g}$ — Basic Equations

ch. 2-5 q_{cond}"

ch. 6-10 q_{conv}"

ch. 11-13 q_{rad}"

(Unit-1) $E_{gen} = (\Delta V)(I)$

$= \dot{q}_{gen} V$

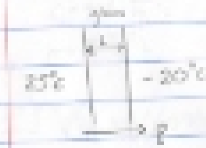
$\frac{W}{m^3}$

$\Delta E_{st} = E_{in} - E_{out} + E_g$

$\text{Balance}_{End} - \text{Balance}_{Start} = \Sigma\,\text{Deposit} - \Sigma\,\text{Withdrawal} + \text{Interest}$

(unit 2) $q = \dot{m}(h_{out} - h_{in}) \rightarrow q = \dot{m} c_p (T_{out} - T_{in})$

$\Delta h = c_p \Delta T$



$q_{cond} = kA \frac{\Delta T}{L}$ — thermal conductivity

200 $k_{Cu} = 413\ \frac{W}{m \cdot K}$

300 $k_{Cu} = 401\ \frac{W}{m \cdot K}$

400 $k_{Cu} = 393\ \frac{W}{m \cdot K}$

$k_{air} = 0.0281\ \frac{W}{m \cdot K}$

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$q_{conduction} = kA\frac{\Delta T}{L}$ $\Delta T = T_1 - T_2$

$q_{convection} = hA\Delta T$ (1.3)   * h = convection coefficient $\left(\frac{W}{m^2 K}\right)$

$q_{radiation} = \varepsilon\sigma A(T_s^4 - T_{sur}^4)$ (1.7) $\sigma = 5.67 \times 10^{-8} \frac{W}{m^2 K^4}$

conservation of energy

1-12a $\dot{E}_{st} = \dot{E}_{in} - \dot{E}_{out} + \dot{E}_{gen}$

1-12e $q = \dot{m} c_p (T_{out} - T_{in})$

Example 1.9

$\dot{E}_{st} = \dot{E}_{in} - \dot{E}_{out} + \dot{E}_{gen}$

$\dot{E}_{st} = m c_p \frac{dT}{dt}$

$mc\frac{dT}{dt} = -q_{conv} + I^2(R'L)$

$q_{conv} = hA\Delta T = h(LD\pi)(T_{wire} - T_{\infty})$

$mc\frac{dT}{dt} = -h(LD\pi)(T_w - T_{\infty}) + I^2(R'L)$

$c = 903 \frac{J}{kg \cdot K}$ $\rho = 2700 \frac{kg}{m^3}$

$m = \rho\frac{\pi D^2}{4}L$

$\frac{dT}{dt}\rho\frac{\pi D^2}{4}cL = -h(LD\pi)(T_w - T_{\infty}) + I^2(R'L)$

→ $\rho\frac{\pi D^2}{4}\frac{dT}{dt}c = -hD\pi(T_w - T_{\infty}) + I^2(R')$

→ $a\frac{dT}{dt} = -b\,T_w + c$

$\frac{dT}{dt} = \frac{-b\,T_w}{a} + \frac{c}{a}$ → $\boxed{\frac{dT}{dt} = -c_1 y + c_2}$

homework: ① differential equations