ENGR 3310 : Transport Phenomena

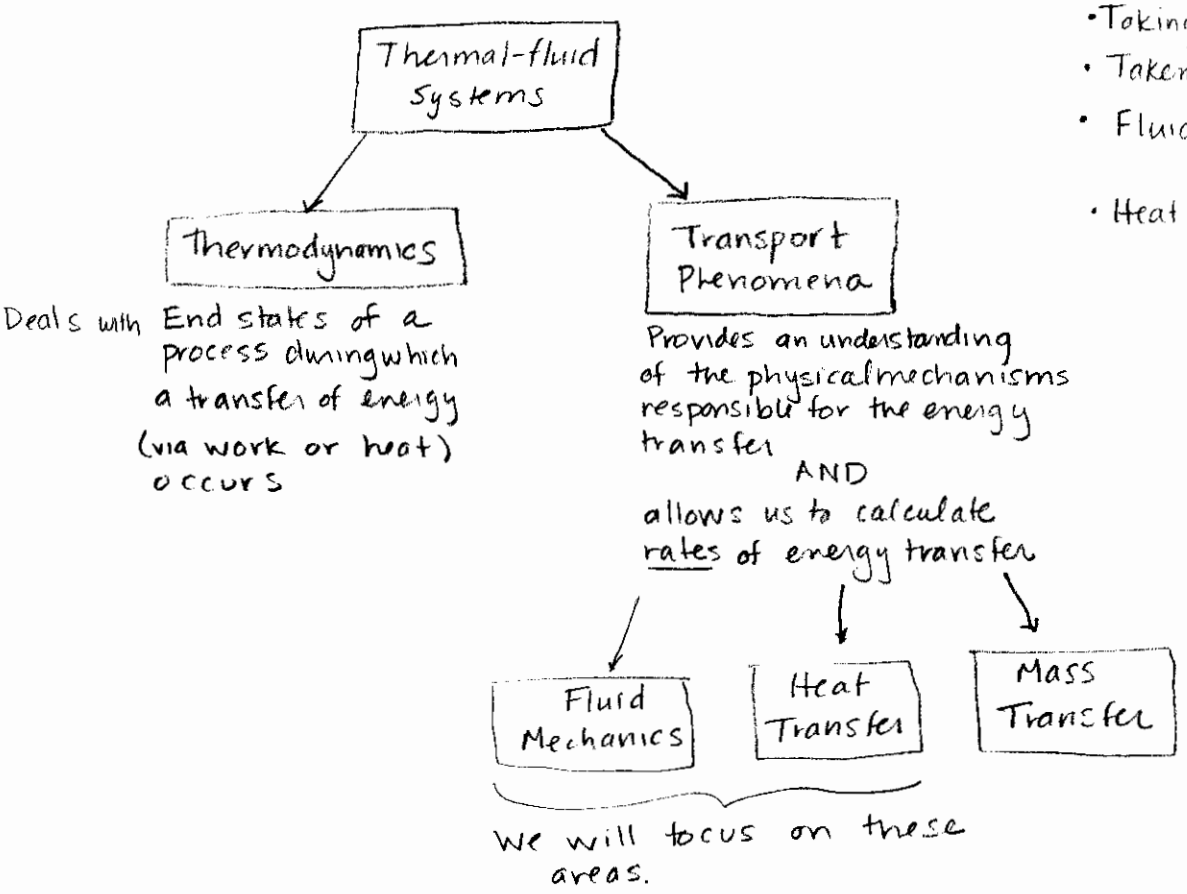
Lecture Notes

- Introductions
- Class logistics, syllabus, website, books
  faculty.olin.edu/~jtownsend/transphenom.htm

→
- Website
- Books
- Attendance
- Mud cards
- Reading assignments
- Competencies
- Homework
- Exams - dates?
- Project
- Lecture/recitation

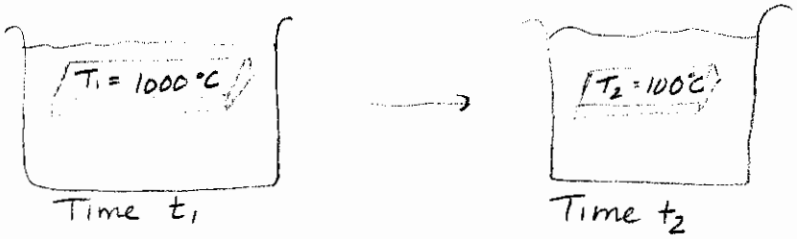
- Intro to Transport Phenomena

Questions:
- Taking PDE's?
- Taken thermo?
- Fluids covered in physics?
- Heat transfer covered in physics?



Example: Difference between thermo + transport phenom.

1 kg ingot of iron quenched in oil bath



Cup of coffee, 100 g

$$\Delta U = (.1\,kg)\left(4.18\,\frac{KJ}{Kg\,K}\right)(85\,^\circ C)$$

$$\Delta U = 36\ KJ$$

Thermo tells us:

Change in internal energy of iron ingot

$$\Delta U = mc\Delta T = (1\,kg)\left(450\,\frac{J}{kgK}\right)(1000-100\,^{\circ}C)$$

$$\Delta U = 405\,kJ$$

How long does this process take?

Heat transfer tells us:

Δt = f (temperature of oil bath, physical properties of oil, motion of the oil, etc.)

Cup of coffee

Δt = f (cup material properties, energy loss through cup, etc.)

Brief
- Review of Thermodynamics
  → Look at Brian Storey's Equation sheet

[Chalk example] for work

1st Law: $dE = \delta Q - \delta W$

dE: state variable, path independent
δQ, δW: path dependent

$E = U + PE + KE$

E: total energy; U: internal energy

2nd Law: $dS \geq \frac{\delta Q}{T}$

Efficiency $\eta = \frac{W_{net}}{Q_{in}}$

Enthalpy: $h = u + Pv$

Thermodynamic property relns: (Combined 1st + second law)

$$Tds = dh - vdP$$

$$Tds = du + Pdv$$

Ideal gas:

$$Pv = RT$$

$$\Delta h = c_p \Delta T$$

$$\Delta u = c_v \Delta T$$

$$\Delta s = c_p \ln\left(\frac{T_2}{T_1}\right) - R\ln\left(\frac{P_2}{P_1}\right)$$

$$\gamma = c_p/c_v$$

Ideal gas
Constant specific heats
isentropic processes $\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^{\gamma}$, $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$

Fluid Mechanics

- Study of fluids in motion or at rest
- Effects of fluid on boundaries
- Compromise between theory and experiment

Heat transfer

- Occurs as a result of a difference in temperature
- Extends thermodynamic analysis (that deals only with end states) to understand the nature of the interaction in transferring heat
- Conduction - heat transfer through a solid
- Convection - transport of energy by motion of a medium
- Radiation - heat transfer via electromagnetic waves or photons

Related

Mass transfer

- Mass in transit as the result of a species concentration difference in a mixture.