29/7/09

2060 Thermal Physics

- Conceptually difficult subject
- Lots of terminology & confusion
- Use a text!

Possible Textbooks:

① A. CARTER

"Classical & Statistical Thermodynamics"

Prentice Hall

Last Year's Recommended Reading

② S.J. Blundell & KM Blundell

"Concepts in Thermal Physics"

O. Ford

③ DV Schroeder

"An Introduction to Thermal Physics"

Addison-Wesley

④ Sears & Salinger

"Thermodynamics, Kinetic Theory & Statistical thermodynamics"

Addison Wesley

REFERENCES (That I am using!)

* H B Callen

"Thermodynamics" John Wiley

- Formal, Postulate-based approach

H.C. Van Ness

"Understanding thermodynamics"

Dover

- Conceptual approach.

Feynman, Leighton & Sands

"The Feynman lectures on Physics Vol 1"

What is thermodynamics About?

- HEAT
- All processes occurring at $T > 0$
- Transformation } of energy
- Transduction } of energy
- Transfer } of energy.
- Transformation of states of matter

Where does Thermodynamics fit in Physics?

CLassical Eqm Thermodynamics

- MACROSCOPIC theory
- statistical theory
- Phenomenological theory

STATISTICAL MECHANICS

- Derive Thermodynamics from statistical properties of constituent particles.
- DEEPER FOUNDATION

NON-EQM THERMODYNAMICS

- 20th century developments

FAR from EQM THERMODYNAMICS & STATISTICAL MECHANICS

- 20th century & Present

→ Biology!

Why study thermodynamics?

Physicist:

ENTRY into
→ Stat. Mech

→ Develop modern understanding of Non eqm & far from Eqm processes.

WORKING on any system at $T > 0$!
states of

- Understand transitions of Matter
  transformations

- Energy transduction
  transformation

EXAMPLES:

- Superconducting phase transitions
- Magnetism
- Properties of low dimensional devices.

Nanotechnologist & Biophysicist

- Systems operating at T ~ 300K (NANOscale)
  in water
  - Fluctuations & thermal energy
- Molecular motors
  - how do they work?

MATHEMATICAL Tools

- PARTIAL DERIVATIVES
- FUNCTIONS of several variables
  - in Particular:
    - ~~two~~ First order homogeneous fcts.
    - Zero order
- LEGENDRE TRANSFORMS
  - conjugate variables.

Rough History of THERMODYNAMICS

Industrial Revolution & study of energy transformation & search for efficient transformation of heat → Mech. work.

- Joule, Helmholtz. -

→ First Law ≡ conservation of energy.

Sadi CARNOT 1824,
→ CARNOT's thm
↔ 2nd Law
- efficiency of Steam engines !

ENTROPY: Clausius 1865

3rd Law: Nernst & Planck

Link S & T=0

⇒ Phenomenological theory describing macroscopic properties of Matter

- Classical (Eqm) thermodynamics.

End of 19th Century

→ Atomic nature of matter

MAXWELL → Kinetic theory of gases

⇒ DEVELOPMENT of Statistical Mech

- Boltzmann
- ~~Gibbs~~ Gibbs

→ Deeper foundation of Thermo

~~first~~ based on statistical theory of ensembles of particles

early 20th c – Quantum Stat Mech

Mid 20th Century:

~~Onsager~~ Onsager, Prigogine

→ irreversible, non-equilibrium Thermodynamics.

→ CHAOS ... COMPLEXITY ....