MAT 501 Thermodynamics
Fall 2022

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Associates: TBA

Course Data: Hours: Mon 14.40-15.30/Tue 14.40-16.30
Office hours: *TBA*

Textbooks:

Callen, H.B., *Thermodynamics and an Introduction to Thermostatistics*, Wiley, 2nd Ed., 1985. QC311 .C35 1985.
Fermi, E., *Thermodynamics*, Dover, 1956. QC311 .F47 2010,

References:

Dill, K.A., Bromberg, S., and Stigter, D., *Molecular Driving Forces*, Statistical Thermodynamics in Biology. Garland Science, 2nd Ed., 2011. QC311.5 .D55 2011.
Reif, F., *Fundamentals of statistical and thermal physics*. McGraw-Hill, 1965. QC175 .R44 1965.

Weeks Commencing/Topics:

Oct 3, 10 Part I
Thermodynamic systems
Piston-gas as a system
- Idealizations and assumptions about the piston, the gas, and the environment

Gases
- Ideal/perfect – what are the assumptions?
- Laws – observations/experiments
- Maxwell's "kinetic" theory

Work done

Oct 17, 24 Part II
Internal energy
- Isolated systems

Heat
- Interactions with the environment – Isothermal, adiabatic, and all else

The first law
- Gases
- Expansions – what variables are fixed? Reversibility for each step or whole process?

The maximum work theorem

Oct 31, Nov 7 Part III
The second law
Cycles
- Carnot – why Carnot? Are there other cycles? A general form of cycles
- Inverted heat engines: Refrigerators and pumps

Entropy
The fundamental equation – and its consequences

Nov 14-15 Recapitulation and **Exam I**

Nov 21, 28 Part IV

Thermodynamic potentials

Helmholtz and Gibbs free energy

- Legendre transformations
- The Maxwell relations

Thermodynamic description of mixtures

Dec 5, 12 Part V

Stability of Thermodynamic Systems

Explain, why

- Addition of heat to a stable system must increase its temperature
- Isothermal expansion of a stable system must decrease its pressure

Le Châtelier's principle and Braun's amendment

Phase diagrams

- Stabilities of phases
- Phase boundaries and typical phase diagrams

Dec 19 Part VI

Phase transitions

- First-order phase transitions in single component systems
- The discontinuity (of the volume – the lever rule; in the entropy – latent heat)
- Phase loci – The Clapeyron equation
- First order transitions in multicomponent simple systems – Gibbs' phase rule

Dec 26-27 Recapitulation and **Exam II**

Jan 2

Phase diagrams for binary systems

Entropy revisited

The Nernst postulate and the Third Law

Recapitulation and the **Final** prep

Class Policies

Course will be in physical mode (finally)!

Grading

Exam I and II: 30% each, total is for 60% of the final grade

Final exam: 40% of the final grade; covers all the material