MAT 501 Thermodynamics
Fall 2021

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Associates: TBA

Course Data: Hours: Mon 10.40-12.30/Tue 09.40-10.30
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.
Zemanksy, M.W. and Dittman, R.H., *Heat and Thermodynamics.* 7th ed. McGraw-Hill, 1997.

Weeks Commencing/Topics:

Sep 27, Oct 4 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 11, 18 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 25, Nov 1 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 8 Recapitulation and the **Midterm**

Nov 15, 22 Part IV
Thermodynamic potentials

Helmholtz and Gibbs free energy
    Legendre transformations
    The Maxwell relations
Thermodynamic description of mixtures

Nov 29, Dec 6 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 13, 20 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
Phase diagrams for binary systems

Dec 27
Entropy revisited
The Nernst postulate and the Third Law
    Recapitulation and the **Final** prep

Class Policies
Course will be hybrid.
All lectures will be synchronized and recorded.

Grading
Quizzes: (5-best/6) of them, one for each "part;" total is for 25% of the final grade
Midterm: 35% of the final grade
Final exam: 40% of the final grade; covers all the material