AEP 4230/PHYS 4230 Statistical Thermodynamics
Syllabus – Fall 2023

Revision Date: 15 August 2023

Instructor: Prof. Craig Féinne
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Office: 224 Clark Hall
Office hours: Wed 15:30 – 16:30

Credits: 4 hours
Course Frequency: Offered every Fall

Lecture Meeting Time & Location:
MWF 10:10am – 11:00am, PSB 120
Discussion Meeting Time & Location:
F 13:25 – 14:40am, PSB 120

Expected Supplemental Hours: About 12 hours per week (3 hours per credit) spent on homework assignments and study of material presented in class.

Course Description: The course starts with the fundamentals of thermodynamics: laws, state variables, Legendre transformations and Maxwell relations. This is followed by a classical approach to equilibrium statistical mechanics. The connection between the partition functions and the thermodynamic variables is developed to couple the statistical mechanics with thermodynamics. Quantum & Semiclassical statistical mechanics, and applications are discussed.

Prerequisites:
AEP 3330, AEP 3610, or equivalent, or permission of instructor

Corequisites:
AEP 4200, or equivalent strongly recommended

Preparation Summary: Students should be familiar with the Engineering Physics or Physics junior level courses in Classical Mechanics, Quantum Mechanics, and Applied Math along with their prerequisites.

Student Learning Outcomes: After completing this course, students should:

- Develop an understanding of the fundamentals of Classical Thermodynamics, Statistical Mechanics, and how the latter underlies the basic physics of the former relation.
- To be able to ``speak" *Thermal Physics*
- To be able to *address the Question ``what do we mean by classical"* wrt a thermal energy scale.
- Begin to develop the ability to teach oneself how to learn
- Begin to develop the ability to work through ill-posed questions concerning everyday physical systems in Thermodynamics Equilibrium.

Topics Covered:

- Basic Definitions and Concepts, review of basic ideas from probability/combinatorics
- Statistics of Thermal Equilibrium, Boltzmann Distribution Function,
- Zero, First, Second, Third Laws of Thermodynamics
- Reversible and Irreversible Processes

- Microstates and Entropy
- State Variables, Legendre Transformations, Maxwell Relations
- Classical Stat Mech, Partition Functions (and Transformations b/w them), Equipartition Thm
- Transformation relations between the Partition Functions
- Blackbody Radiation, Planck's radiation Law
- Heat Capacity: Einstein Model, Debye Model
- Quantum & Semiclassical Statistical Mechanics: Maxwell-Boltzmann, Fermi-Dirac, Bose-Einstein
- Example: Fermi Gas, Neutron stars/black holes, Bose-Einstein condensation
- Phase Transitions
- Intro to Irreversibility & Onsager's Reciprocity

Class Format:
Lecture: 3, 50-minute lectures per week
Discussion: 1, 75-minute discussion per week (Yes, Discussion Meetings are required)

Textbooks and/or Other Required Materials:
Blundell & Blundell - Concepts in Thermal Physics (Required) We will follow it rather closely.
Landau & Lifshitz – Statistical Physics, Vol 5 (Recommend)

Assignments
- Homework**:** Written and reading Homework will be given (almost) every class.
- Discussion Meetings**:** You should have a write-up of the assigned problems from the week before (up to Monday of that week) with you during the weekly **Discussion Meetings.**

Methods of Assessing Student Achievement
- **Homework** will **not** be collected. It is your responsibility to attend weekly **Discussion Meetings**, where model problems generated by the TAs will be worked through. This is your opportunity to ask questions on the assigned homework.
- **Quizzes**. There will be 4 Quizzes, each given during a Discussion Meeting. There are no makeups.
- **Final**. There will be a Final Exam during the (Cornell) published day and time.

Grading Policies: The following percentages are used to tally a final grade:
- 3 of 4 quizzes (you get to drop 1 quiz, for whatever reason) 60%
- Final Exam 40%

The ***Median grade*** in the course will be set to a B+.

Attendance Policy:
Students are expected to attend all lectures and discussion sessions.

Inclusive Learning Environment:
Students come from many different backgrounds and bring a wide variety of strengths, as well as different approaches to solving problems and viewing the world. This is a strength of Cornell and we value all of our students, and insist that everyone treat colleagues with respect and consideration. You are encouraged to learn with, and from, each other in an inclusive manner.

Academic Integrity

Students are expected to abide by the Cornell University Code of Academic Integrity with work submitted for credit representing the student's own work. Discussion and collaboration on homework is encouraged, but final work should represent the student's own understanding. Course materials posted on Canvas are intellectual property belonging to the author. Students are not permitted to buy or sell any course materials without the express permission of the instructor. Such unauthorized behavior will constitute academic misconduct.

Diversity and Inclusion

You can expect a safe and respectful environment for everyone in class, clear instruction and empathic support of your learning, including individual help outside of lectures. The instructors and TAs will present the course material, show you the techniques and applications, guide you through solving problems, and provide additional help during office hours. We will be there for you, help you improve and succeed, address the needs of students requiring special accommodations and resolve all administrative issues. We all learn differently and at different paces. Everyone in the class should thoroughly enjoy this class and succeed with numerous take- aways.

Every single one of you is important and valued. Any raised point or concern by anyone will be done in a respectful manner, in an inclusive and welcoming manner, and discussion will be encouraged, in-class and/or in private. There are no stupid questions. We form a diverse body of human beings where sex, sexual orientation, religion, gender, language, ability, place of origin is an asset to our mutual learning experience. You are here to learn the course material, and we are here to learn and adapt from/to your needs - it's a two-way street.