Statistical Mechanics

PHY 332-0, Spring 2022

https://canvas.northwestern.edu/courses/164817

Professor: Michelle Driscoll
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office: F247
office hours: Tuesdays 3-4pm, or by appointment (email me or feel free to drop by my office)

Class Hours

Lecture: MWF 1:00-1:50 Tech F281
Discussion: M 3:00-3:50 Tech L160 *(no discussion the week of 3/28)*

Course Summary

This course covers the basics of thermodynamics and an introduction to statistical physics, including the ideal gas, Boltzmann distributions, transport phenomena, fluctuation theory, and other applications.

Learning Objectives

This course will introduce students to thermodynamics and probability, and use these tools and concepts to relate the microscopic and macroscopic descriptions of thermal systems. In particular, students will learn how to specify the macrostate & accessible microstates of a system, chose the appropriate ensemble, and then use this information to calculate mean values and statistical properties of the system.
Every discussion section will begin with a quiz, and then the remainder will be used for extensional examples as well as an opportunity for questions and additional disuccsion of course material.

Textbook

Statistical and Thermal Physics: With Computer Applications, 2nd edition (Gould & Tobochnik)
ISBN-10: 0691201897
Cost: $73 hardcover; the e-book can be rented for $30 for the quarter.

Grading

Weekly Problem Sets: 35% (7×5%)
Weekly Quizzes: 35% (7×5%)
Final Project: 30%

Problem Sets

The problem sets will give a chance to practice the methodology of statistical mechanics. There will be eight total problem sets, but only your highest seven scores will be counted towards your grade. You are welcome and encouraged to work together on the problem sets, but the work you turn in to me should be your own. Problem sets will be due every Wednesday at the beginning of class, after which they are considered late. Late assignments will be assessed a penalty of -10%/day, and will no longer be accepted past 4 days late (Sunday of the week they are due).

Weekly Quizzes

Every week the discussion section will begin with a quiz. The quizzes will be quite similar to the previous week's problem set, so making sure you thoroughly understand the problem set should be preparation enough for the quiz. There will be eight total quizzes, but only your highest seven scores will be counted towards your grade. If you are unable to make it to the discussion section, you must contact Michelle in advance to make alternative arrangements for that week's quiz.

Final project

The final project is your chance to explore a modern concept in statistical mechanics in more depth; at its core you will chose a research paper and summarize it. Prof. Driscoll will be providing a list of papers, but you are free to chose a paper not on the list with her approval. Understanding and presenting a research paper can be a daunting task, so Prof. Driscoll will guide you through the process in a scaffolded manner. Thus, though the final write-up of the project will be due during finals week, the grade for this project will be multi-part, with small portions of the project to be turned in throughout the quarter. Details on the expectations for (and grading of) each part of the project will be made clear as the course progresses.

Course Outline

Below is the planned schedule for the course - *it is subject to change during the quarter.* Due dates are subject to be changed, but will only shifted to a later date, never earlier. A quiz will be given in discussion section every week that it meets (Weeks 2-9).

	Lecture Topics	**Assignment Due**
Week 1	class intro / thermodynamics	
Week 2	thermodynamics	Problem Set 1
Week 3	probability / intro to microstates	Problem Set 2
Week 4	intro to microstates / enumerating states	Problem Set 3, project: chose topic
Week 5	microcanonical ensemble	Problem Set 4, project: one paragraph summary
Week 6	canonical ensemble & applications	Problem Set 5, project: key stat mech points
Week 7	grand canonical ensemble	Problem Set 6, identify additional literature
Week 8	magnetic systems	Problem Set 7, project: 3 key points
Week 9	chemical potential / guest lecture	Problem Set 8, project: 1 slide summary
Week 10	*no lecture*	project: brief presentation
Finals		project: final write-up

Academic Integrity Statement

Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit: https://www.northwestern.edu/provost/policies/academic-integrity/index.html

Accessibility Statement

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

Statement of Inclusivity

This course strives to be an inclusive learning community, respecting those of differing backgrounds and beliefs. As a community, we aim to be respectful to all students in this class, regardless of race, ethnicity, socio-economic status, religion, gender identity or sexual orientation.

Support for Wellness and Mental Health

Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL), and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here:

https://www.northwestern.edu/counseling/
https://www.northwestern.edu/religious-life/
https://www.northwestern.edu/care/

COVID-19 Testing Compliance Statement

To protect the health of our community, Northwestern University requires unvaccinated students who are in on-campus programs to be tested for COVID-19 twice per week. Students who fail to comply with current or future COVID-19 testing protocols will be referred to the Office of Community standards to face disciplinary action, including escalation up to restriction from campus and suspension.

COVID-19 Classroom Expectation Statement

Students, faculty, and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the COVID-19 Code of Conduct. With respect to classroom procedures, this includes:

- Policies regarding masking and social distancing evolve as the public health situation changes. Students are responsible for understanding and complying with current masking, testing, Symptom Tracking, and social distancing requirements.
- In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.
- No food or drink is allowed inside the classroom.
- Faculty may assign seats in some classes to help facilitate contact tracing in the event that a student tests positive for COVID-19. Students must sit in their assigned seats.

If a student fails to comply with the COVID-19 Code of Conduct or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

Exceptions to class modality

Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU. Maintaining the health of the community remains our priority. **If you are experiencing any symptoms of COVID do not attend class and update your Symptom Tracker application right away to connect with Northwestern's Case Management Team for guidance on next steps. Also contact the instructor as soon as possible to arrange to complete coursework.** Students who experience a personal emergency should contact the instructor as soon as possible to arrange to complete coursework. Should public health recommendations prevent in person class from being held on a given day, the instructor or the university will notify students.

Guidance on Class Recordings

This class or portions of this class will be recorded by the instructor for educational purposes. Your instructor will communicate how members of the class can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Prohibition on Recording of Class Sessions by Students

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty

own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.