Statistical Mechanics Fall 2020 Kansas State University
PHYS 971 Lecture TU for 75 minutes ~~CW146~~ → online via zoom

Main Text: *Statistical Mechanics*, Pathria & Beale, 3rd ed. (2011), Elsvier Ltd.

Alternative Texts: Well-known books by D. A. McQuarrie or by F. Reif.

Professor: Gary Wysin, Cardwell 309, 532-1628. Office Hours: via zoom by email request.
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https://ksu.zoom.us/j/91792514095

Overview

In this course the goal is to learn mainly about statistical physics for systems in thermal equilibrium. That means systems with nearly uniform properties (such as constant temperature, pressure, etc.) in static situations. Equilibrium stat mech applies to a very wide variety of materials and systems, such as ideal gases, crystals, and others where there are weakly interacting atoms or even weakly interacting excitations such as phonons, where there is no time dependence. The basic principle is that enumeration of available microscopic states, together with probability theory, is used to calculate macroscopic properties such as equations of state, heat capacity, and magnetization. A secondary goal will be to consider some advanced problems, where time dependence is of interest, such as kinetic theory and transport.

We plan to cover at least the first eight chapters of the text for the equilibrium topics. After that, there are a few more advanced topics including phase transitions, nonequilibrium such as Langevin theory, and quantum field approaches that can be studied, depending on the time available. I welcome your comments about which topics are most interesting for you, and which topics we could skip because you have sufficient knowledge about them.

Please attempt to read the current chapter before lectures. If you don't read something before coming to lecture, you could be lost or at a disadvantage. In class many things may not be clear to you, so, please ask questions. You may not be the only one who wants and really needs a further explanation. Maybe the misunderstadings you have will be answered in class if you actively participate.

Course Work and Grading

Homework (30%)

The purpose of homework is for you to have understanding and practice in problem solving and in communication of that solution. Written homeworks will be due on Tuesdays. The problems can be discussed with your classmates but **you must write your solution on your own**, so that you understand it. If you work with other people then you should acknowledge that on the paper, for instance, by writing something like "I worked with Stacy Statistic on this assignment." You should also cite any other published or online sources you might have used. Your lowest homework score will be dropped.

You can probably google every assigned problem and find a solution somewhere. But what is the value of that? A big part of learning is using your brain to work over something, either consciously or unconsciously. Being knowledgable in a field does not mean knowing how to "research it" on the internet. You're not an expert if you have to look everything up. And I don't want to read or grade copied solutions, besides that being an honor code violation. Please try to think that you are training to become an expert in the field, to whom other people come for questions. Someone has to be an expert, why not you?

Generally, a problem solution should state the problem to be solved (what is given and what is to be found or derived?), the basic concept or physics ideas that are used to solve it, and then a combination of word explanations and mathematics that is used to elaborate the solution. If some interesting result

is found you might also explain why it is expected, or why it makes sense based on physics principles, or perhaps why it is unusual. It should be written so other students in the course could understand it. Try to be as clear and organized as possible. If you can't write clearly by hand then you aren't communicating. You may need to type your work (i.e., LaTeX or something like that). But it should not be only math formulas.

Two Mid-Term Exams (40%)

There will be two written mid-term exams, see the schedule for the expected date and topics to be covered. I hope we can find a time outside the normal lecture time to do the exams. No exams will be dropped, so it is important to verify the schedule and be sure to be present. You will do exams remotely and synchronously while keeping an open video and audio connection in zoom. You may ask questions to me via email or zoom chat during an exam for clarifications.

Final Exam (30%)

The final exam takes place 9:40 – 11:30 a.m., Friday, Dec. 11. It will cover all the topics from the semester. (See the KSU exams schedule at https://courses.k-state.edu/fall2020/information/xam.html).

Grading Scale:

The grading scale is A (100 – 88%), B (88 – 76%), C (76 – 64 %), D (64 – 52%), F (52 – 0%).

Tentative Weekly Schedule (Pathria & Beale, Statistical Mechanics)

Week of	Book reference	Topics
Aug. 18	App. H, 1.1–1.5	Intro. & thermo. review, SM–thermo connections.
Aug. 25	2.1–2.5	Ensemble theory–mainly microcanonical.
Sep. 1	3.1–3.4	Canonical ensemble, probabilities, partition functions.
Sep. 8	3.1–3.10,	Canonical ensemble, fluctuations, applications.
Sep. 15	4.1–4.6	Grand canonical ensemble, fluctuations.
Sep. 22	5.1–5.3	Quantum statistics, density matrices.
Sep. 29	5.1–5.5	Examples of quantum statistics for free particles.
Oct. 5?	Chaps. 1–5	**Midterm Exam 1.**
Oct. 6	6.1–6.3	Ideal quantum gases, statistics, kinetics.
Oct. 13	6.1–6.6	Ideal diatomic gases, rotations, vibrations; chemical equilibrium.
Oct. 20	7.1–7.3	Ideal degenerate Bose gases, condensation, black-body-radiation.
Oct. 27	7.1–7.6	Einstein & Debye theory of phonons, excitations in liquid helium.
Nov. 3	8.1–8.5	Ideal degenerate Fermi gases, magnetic behavior, metals..
Nov. 10	10.1–10.4	Nonideal gases, virial and cluster expansions.
Nov. 16?	Chaps. 6–10	**Midterm Exam 2.**
Nov. 17	12.1-12.7	Gas/liquid & magnetic phase transitions, mean-field theories, criticality.
Nov. 24	none	Thanksgiving Break.
Dec. 1	12.9, 13.2	Landau theory, 1D Ising model.
Dec. 11	Comprehensive	**Final Exam, 9:40 – 11:30 a.m.**

Mandatory University Statements - please read carefully

Academic Honesty: Kansas State University has an Honor and Integrity System based on personal integrity, which is presumed to be sufficient assurance that, in academic matters, one's work is performed honestly and without unauthorized assistance. Undergraduate and graduate students, by registration, acknowledge the jurisdiction of the Honor and Integrity System. The policies and procedures of the Honor and Integrity System apply to all full and part-time students enrolled in undergraduate and graduate courses on-campus, off-campus, and via distance learning. The Honor and Integrity System website can be reached via the following URL: www.k-state.edu/honor. A component vital to the Honor and Integrity System is the inclusion of the Honor Pledge which applies to all assignments, examinations, or other course work undertaken by students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." A grade of XF can result from a breach of academic honesty. The F indicates failure in the course; the X indicates the reason is an Honor Pledge violation.

Disabilities: Students with disabilities who need classroom accommodations, access to technology, or information about emergency building/campus evacuation processes should contact the Student Access Center and/or their instructor. Services are available to students with a wide range of disabilities including, but not limited to, physical disabilities, medical conditions, learning disabilities, attention deficit disorder, depression, and anxiety. If you are a student enrolled in campus/online courses through the Manhattan or Olathe campuses, contact the Student Access Center at accesscenter@k-state.edu, 785-532-6441; for K-State Polytechnic campus, contact Julie Rowe, Diversity, Inclusion and Access Coordinator, at jarowe@ksu.edu or call 785-826-2971.

Expectations for Classroom Conduct: All student activities in the University, including this course, are governed by the Student Judicial Conduct Code as outlined in the Student Governing Association By Laws, Article V, Section 3, number 2. Students who engage in behavior that disrupts the learning environment may be asked to leave the class.

Statement Regarding Wearing of Face Coverings: To protect the health and safety of the K-State community, students, faculty, staff and visitors must wear face coverings over their mouths and noses while on K-State campuses in all hallways, public spaces, classrooms and other common areas of campus buildings, and when in offices or other work spaces or outdoor settings when 6-feet social distancing cannot be maintained. In addition, all students, faculty, and staff are required to take the COVID-19 and Face Mask Safety training. Employees who need reasonable accommodations and assistance related to required face coverings may contact the ADA coordinator at charlott@k-state.edu, and students needing accommodations may contact the Student Access Center at accesscenter@k-state.edu.

In classrooms, faculty have the right to deny a student entry into the room if the student is not wearing a face covering. Students not wearing a face covering will be reminded to do so and offered a clean face covering, if one is available. If the student does not comply, the faculty member will ask the student to leave the space, and if available, join the class remotely. As a last resort, campus police will be called. The faculty members will complete the Code of Conduct form and the Office of Student Life will look further into the issue and take the non-compliance with the request to leave into consideration of further accountability measures.

At no point should the professor or other students put themselves into an unsafe situation while attempting to enforce the face-covering policy. Manhattan campus police: 785-532-6412.

Student Resources Statement: K-State has many resources to help contribute to student success. These resources include accommodations for academics, paying for college, student life, health and safety, and others found at www.k-state.edu/onestop .

See http://www.k-state.edu/provost/resources/teaching/course.html for further information on University policies.