Physics 435, 2020 Fall

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1 Basic information

Course title	Physics 435, Thermodynamics & Statistical Mechanics.
Instructor	Palash Banerjee
Contact	B201 Science, palash.banerjee@uwsp.edu.
Office hours	On Zoom, by appointment.
Zoom link	`https://uwsp.zoom.us/j/96906839827?pwd=dE85MVc2WWlhVjNyU0hhWmh5b1E0dz09`
Pre-requisite	Physics 250 and Math 222 (Calculus III).
Textbook	*"An Introduction to Thermal Physics"* by Daniel V. Schroeder.

2 Course description

Thermodynamics is the study of heat transfer and mechanical work and engines and refrigerators. It is also the subject of the *greatest law* in all of physics — the 2nd law of thermodynamics. Statistical Mechanics is thermodynamics at the molecular level. This statistical theory lets us describe the average behavior of a very large number of particles. We use this theory to explain the laws of thermodynamics and discover where these laws come from. But the real predictive power of statistical mechanics emerges when we merge it with quantum mechanics to form quantum statistics. The awesomeness of quantum statistics lets us talk about the properties of electrons in metals, the properties of white dwarfs and neutron stars and the properties of the cosmic microwave background radiation within a *single* unified framework. And there lies the full power of statistical mechanics.

3 Learning outcomes

One learning outcome is that you should learn some upper level physics and show me you can make specialized scientific arguments with the proper conceptual and mathematical reasoning. You will demonstrate you can do so by solving different types of problems and submitting a neatly written account of your work.

A second learning outcome is that you should be able to improve your writing. If you write clearly, you will think clearly and this will sharpen your analytical skills.

4 Course assignments

1. **Video lectures:** Each week I will post about five or six video lectures on a topic. Please watch these video lectures and take notes as if you were in an in-person classroom. A homework assignment will accompany the video lectures. I will supplement these videos with some of my own notes.

2. **In-person class:** We will meet in CCC101 twice a week on Tuesday and Thursday at 10 am for an in-person class. Please wear a face covering since I am not allowed to start the class unless everyone is wearing one. I will hand out a short assignment and we will work on it together in my presence. The assignment should sharpen your focus and help you with your homework. It would help if you have already watched a few of the videos *before* you attend our in-person class.

3. **Zoom class:** I will host a class on Zoom Fri 10 am. I will use this time to either provide additional examples or lecture for a bit on some complicated topic.

4. **Homeworks:** Homework will be assigned with every weekly module and will be due in one week. You may expect approximately twelve homework assignments during the course. Your homeworks count for 50% of your grade and I will drop the lowest homework score. To submit your homework, you can use the OneDrive application on your smart phone to take pictures of each page. The application will merge all the pictures into a single pdf file. You can then upload the pdf file onto Canvas.

5. **Exams:** There will be *two* midterm exams during the semester and one final exam. The three exams taken together count for 50% of your grade. The exams are open notes and you can refer to whatever resources you wish. I only ask that you *not* talk to or otherwise get help from another person. Your written solutions are due within 24 hours on Canvas.

5 *Grading and evaluation*

I will calculate your grade based on a weighted percentage of your scores as shown in the table to the left below. Your final letter grades will be determined as shown in the table to the right below.

Assignment	Value
Homeworks	50%
1st exam	16%
2nd exam	16%
Final examination	18%

Total score	Grade
90% and above	A
87–89%	A-
84–86%	B+
80–83%	B
77–79%	B-
74-76%	C+
70–73%	C
67–69%	C-
64–66%	D+
60–63%	D
below 60%	F

I do *not* grade on a curve. Scores will be rounded up according to the following example: 86.6 – 86.9% will be rounded up to 87% and become a A-, but 86.0 – 86.5% will remain at 86% and will earn a B+.

6 *Other course policies*

1. If you are going to be late on an assignment, please let me know. It will be difficult for me to accept a late assignment after I post the solutions.
2. I will drop the lowest homework score. *All* the exams count.
3. The dates for the final exam are set by the University. It will be very difficult for me to have anyone take an early final exam.
4. I do not assign work for extra credit.
5. Once you hand in your final exam, there is nothing more you can do to change your grade.

7 *Course schedule*

The course schedule is shown in the table below. I will try my best to follow this schedule but I reserve the right to make changes.

Week	Topic
(1) Sept 2	We learn about state variables and ideal gases.
(2) Sept 6	We encounter the ideal gas law and learn to draw pV diagrams
(3) Sept 13	We are introduced to probability theory, macrostates, and microstates.
(4) Sept 20	We meet the statistical definition of temperature.
(5) Sept 27	We derive the Maxwell-Boltzmann distribution and learn how to calculate averages.
(6) Oct 4	We revisit the ideal gas law and see where it comes from. Mid term exam 1
(7) Oct 11	We meet the first law of thermodynamics.
(8) Oct 18	We study reversible processes and prepare to meet the heat engine.
(9) Oct 25	We encounter the *greatest law* in physics — the 2nd law of thermodynamics.
(10) Nov 1	We discover how the 2nd law imposes limits on the efficiency of heat engines.
(11) Nov 8	We meet the mysterious thermodynamic potentials and find a use for partial derivatives. Mid term exam 2
(12) Nov 15	We meet the partition function and find multiple reasons to use it.
(13) Nov 22	We merge Statistical Mechanics with Quantum Mechanics to form Quantum Statistics.
(14) Nov 29	We study Bose-Einstein statistics and the properties of a photon gas.
(15) Dec 6	We study Fermi-Dirac statistics and the properties of degenerate fermions.
(16) Dec 14	Final exam, available Mon Dec 14, 8 am, due by 5 pm