

PHYS 462/662 Thermal and Statistical Physics Fall 2020

Course #4082-4083 (3 credits)

Instructor: Dr. Alan R. Denton alan.denton@ndsu.edu
Professor, Dept. of Physics office: SE 214B, NDSU

Classes: Tuesday & Thursday, 4:30-5:45 p.m., SE 208

Office Hours: In person and virtual (times TBA)

Bulletin Description:

Classical postulates and laws of thermodynamics; cyclic processes and entropy; thermodynamic potentials, equilibrium, stability, and phase transitions; Maxwell-Boltzmann distribution, applications to classical gases and magnets; quantum statistics, Bose-Einstein and Fermi-Dirac distributions, applications to quantum gases.

Objectives: Students will master the foundations of thermodynamics and statistical mechanics and learn to apply theoretical and computational methods to model physical systems ranging from fluids (gases, liquids) to solids and magnets. Graduate students will strengthen their research skills by completing a project on a topic relevant to the course.

Format: Students are expected to review assigned resources in advance and attend class prepared to discuss and work through guided exercises. You are not expected to fully understand the material before class, but be familiar with terminology and definitions. In this way, class time can be used more effectively to deepen conceptual understanding, strengthen problem-solving skills, and discuss practical relevance and applications.

Preparation: Basic knowledge of mathematical methods, mechanics, quantum physics.

Resources: D. Schroeder, *An Introduction to Thermal Physics* (Addison-Wesley, 2000)
Lecture notes, videos, computer simulations in Open Source Physics Library

Evaluation:	Homework	100 pts
	Exams	150 pts
	Quizzes	50 pts
	Project (graduate students)	100 pts
	<u>Total</u>	<u>300/400 pts</u>

See project guidelines for requirements and assessment of the graduate research project. Attendance is expected (NDSU Policy 333, www.ndsu.edu/fileadmin/policy/333.pdf), but face masks and physical distancing (2 m separation) are required in the classroom. Note: *Requests for remote participation will be accommodated through video conferencing.* Active engagement in class discussions is strongly correlated with success in this course!

Homework: Assignments will be posted on Blackboard (<https://bb.ndsu.nodak.edu>). While discussion of homework with classmates is encouraged, submitted work must be your own. Similarity to work of other students or to internet solutions will yield no points. Late homework will be accepted with a penalty of 20% per day.

Quizzes: Reading quizzes and check-up quizzes will be posted on Blackboard.

Grading: A: $\geq 90\%$, B: 80 to $< 90\%$, C: 70 to $< 80\%$, D: 60 to $< 70\%$, F: $< 60\%$
Grades will not be curved and any shift in grade boundaries will be only in your favor.

Preliminary Schedule

Week	Topics	Reading
1	Thermodynamic systems and postulates	Chap. 1
2	Energy, work, heat and the First Law of Thermodynamics	Chap. 1
3	Cyclic processes and thermal engines	Chap. 4
4	States, entropy, and the Second Law of Thermodynamics	Chap. 2
5, 6	Ideal and interacting systems, thermodynamic equilibrium	Chap. 3
6, 7	Free energy and thermodynamic phase stability	Chaps. 1-4
8	Equations of state, phase transitions, and critical phenomena	Chap. 5
9	Thermodynamic potentials (Legendre transformations)	Chap. 5
10, 11	Microstates, macrostates, phase space, ensembles, Second Law	Chap. 2
11, 12	Classical statistics: Maxwell-Boltzmann distribution	Chap. 6
13, 14	Applications: ideal gases, paramagnets, and ferromagnets	Chaps. 1-6
14, 15	Quantum statistics: Bose-Einstein and Fermi-Dirac distributions	Chap. 7
16	Systems of interacting particles, computer simulation methods	Chap. 8
17	Final Exam: week of Dec. 14	Chaps. 1-8

Computational Examples and Exercises in Statistical Physics

To supplement “textbook-style” problems, deepen conceptual understanding, and build computational skills, we will use *PhET Interactive Simulations* from the University of Colorado Boulder and *Simulations in Physics* in the Open Source Physics Library, free Java software that can be downloaded, compiled, and run on any computer.

Contingency Plan for Remote Instruction and Learning

Requests for remote participation due to concerns over COVID-19 will be accommodated. See attached COVID-19 Related Information.

Should any circumstances necessitate strictly online instruction, all course resources will remain accessible through Blackboard and communications and interactive discussions will continue via email and video conference (e.g., Zoom, Blackboard Collaborate Ultra).

The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at www.ndsu.edu/academichonesty.

All access to NDSU computers must respect NDSU Senate Policy, section 158:

Acceptable use of Electronic Communication Devices

<https://www.ndsu.edu/fileadmin/policy/158.pdf>

Any students with disabilities or other special needs, who need special accommodations in this course are invited to share concerns or requests with the instructor and to contact the Disability Services Office (www.ndsu.edu/disabilityservices) as soon as possible.

COVID-19 Related Information

Communication

Course-related information will be communicated primarily during synchronous class meetings. Reminders and notifications of any schedule changes will be communicated through NDSU email and posted on the Blackboard announcements page.

Your NDSU email address is the official route for course-related information.

You may participate virtually and synchronously in this course via Zoom, requiring WiFi, video, and audio capabilities. Office hours will be conducted via Zoom. You may also meet with me in person during office hours (please remember to wear a face covering).

If you have any technology concerns, please contact the IT Help Desk:

[ndsuhelpdesk@ndsuhelpdesk.edu](mailto:ndsuhelpdesk@ndsuhelpdesk@ndsuhelpdesk.edu) 701-231-8685 (option 1)

Submission of Assignments and Posting of Grades

All students (both face-to-face and remote participants) will submit assignments through our Blackboard course homepage, where all grades will be posted.

Copyright of Course Materials

Recording any class meetings with your own personal devices is strictly prohibited. See NDSU [Policy 190](#) on Intellectual Property.

Health and Safety Expectations

Information on COVID-19 and NDSU's response:

https://www.ndsu.edu/admission/fall_2020_prelim_plan

Please follow NDSU guidance on face coverings, physical distancing, and sanitation:

NDSU requires students to wear face coverings in classrooms. Wearing a face covering helps reduce the risk to others in case you are infected but do not have symptoms, and also may protect you from infection.

If you attend class in person, you must properly wear a face covering (covering both the mouth and nose) for the entire class. If you fail to properly wear a face covering, you will not be admitted to the classroom. However, you may choose to participate remotely.

Failure to follow NDSU guidelines will result in referral to the Dean of Students Office or administrative removal from class. Students who cannot wear a face covering due to a medical condition or disability may seek accommodation through Disability Services:

701-231-8463 <https://www.ndsu.edu/disabilityservices/>

Disinfecting supplies are provided for you to disinfect your learning space. You may also use your own disinfecting supplies.

Whenever possible, observe physical distancing guidelines, maintaining 2 m separation from others. Avoid congregating around the classroom entrance before or after class.

In accordance with NDSU [Policy 601](#), failure to comply with instructions, including this syllabus, may be handled according to the Code of Student Conduct resolution process and may result in disciplinary sanctions.

Food and drink are not allowed in class except with a documented accommodation through Disability Services (since consumption obviously requires removing your mask).

Do not come to class if you are sick. Please protect your health and the health of others by staying home, where you may participate remotely. For information on COVID-19, symptoms, testing, and steps to stay healthy see

https://www.ndsu.edu/studenthealthservice/covid_19/

Do not come to class if you have been exposed to individuals who tested positive for COVID-19 and/or you have been notified to self-quarantine due to exposure.

If you are unable to attend class at the scheduled time due to illness or exposure, contact me for alternate arrangements, including accommodations and extensions.

If you are absent from class as a result of a COVID-19 diagnosis or quarantine, the decision for approval of all absences and missed work is determined by the course instructor. As instructor, I will do the following to help you make progress in the course:

You will be able to participate in class remotely.

You will be able to submit assignments and take exams remotely.

Other remote learning options will be determined on a case-by-case basis.