Thermal and Statistical Physics

PHY-333 Fall 2022

MEETINGS T/Th 11:30-1:00PM

INSTRUCTOR

Mariel Meier
Associate Professor of Physics

BEST WAYS TO REACH ME

Email: mmeier@oglethorpe.edu
Office Hours: M/T/F 2:00-4:00PM Cousins 106

COURSE DESCRIPTION

This course explores the concepts of energy and materials through a theoretical physics lens. Beginning with thermal physics we will discover how the properties of systems relate to each other and how these properties can be manipulated. Later in the semester we will use statistical methods to understand how those properties are actually the result of the behavior of the individual particles that make up the system. Some of the applications we will consider include ideal gases, engines, power plants, magnetic materials, blackbody radiation, white dwarf stars, and more. Because energy is such a ubiquitous concept, you will have the opportunity to choose a topic or application that is of interest to you and uncover more about how we can apply the mathematical and computational methods of this course to further our understanding of that topic.

LEARNING OBJECTIVES

After completing this course, you should be able to

01 Relate small-scale behavior of systems to their large-scale properties both qualitatively and quantitatively.

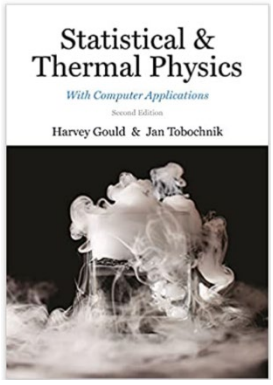
02 Apply fundamental concepts of thermodynamics to understand the behavior of a novel system.

03 Use the results of computational simulations to make predictions about system behavior.

04 Communicate complex scientific ideas through writing and oral presentation.

COURSE RESOURCES

Statistical and Thermal Physics 2nd edition by Gould & Tobochnik (2021)



All other **required** materials will be posted to Canvas.

COURSE ATTENDANCE

This course will be face-to-face and interactive, and regular attendance is expected. You may take **3 absences** from class for any reason – you do not need to explain yourself. Each additional absence will result in a 3-point deduction in your final course grade. Arriving to class more than 15 minutes late will be considered an absence.

In the case of documented illness, we can arrange for you to join class via Teams, but arrangements must be made at least 12 hours in advance.

DETAILED COURSE INFORMATION IN CANVAS

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COURSE POLICIES

LIFE TOKENS

Life happens. Use up to **3 life tokens** for a no-questions-asked deadline extension for up to 3 days on any problem set or portion of the final project.

Let me know when you are using a life token. Just an email saying "Hey Dr. Meier, I'm using a life token on x assignment" will suffice.

DUE DATES

Assignment due dates are designed to help you progress through the course while engaging in deep learning. All due dates are non-negotiable. Assignments turned in after the due date will receive a 10-point deduction per 24 hours unless you have indicated you are using a life token.

WORKING WITH OTHERS

Science is not a solitary activity, and you are expected to work with other students and ask questions via email/during office hours when completing problem sets. That having been said, it is easy to fall into a trap of accepting too much help. It is your responsibility to make sure you really understand the material!

FEEDBACK

Typical response time for non-urgent emails:
24 - 48 hours
Typical grading return: 1 week after submission

ACCESSIBILITY

If you need any accessibility-based accommodations, please go through the Office of Accessibility Services to obtain documentation. Once I receive a request for accommodations I will arrange a one-on-one meeting with you to discuss how I can support your request.

TECHNOLOGY IN THE CLASSROOM

Cellphones may be kept on the table/desk in silent mode. Any student observed texting during class will be asked to stow their cellphone. Computers may be used for notetaking; misuse of devices will result in you being asked to leave the class. During some classes we may work on computers; I will let you know at least 12 hours before class if you will need to bring a device.

ACADEMIC HONESTY

The honor code, as outlined in Section 11 of the current Oglethorpe University Bulletin, applies to all aspects of this course. Any student suspected of violating the honor code will be reported to the Honor Council. Specific assignments may have additional constraints or expectations related to academic honesty and integrity; this will be indicated in the assignment instructions.

QUESTIONS AND CONCERNS

HERE TO HELP

If at any time you feel that you are falling behind with the material, **please contact me.** There are many ways we can work together to help you better understand the concepts and improve your quantitative analysis skills. It is my goal to make the material as accessible as possible, while still addressing the learning goals of the course.

RESPECT FOR DIVERSITY

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

COUNSELING SERVICES

Free and confidential counseling services are available on campus. Licensed counselors are here to provide a space where you can get support and guidance privately about whatever is on your mind. For more information see their website, e-mail counselingcenter@oglethorpe.edu, or text inquiries to 1 (470) 231-5836.

ACADEMIC SUCCESS

Although this course does not have a dedicated tutor, often challenges arise from integrating mathematics concepts with physics. I encourage you to use the math tutors available from the Office of Student Success in order to review math concepts that are used within this course.

SUPPORT IN THE DIVISION

If you ever feel that there are issues with this course that you are not comfortable discussing directly with me, you may contact the chair of the division, Dr. Charles Baube (cbaube@oglethorpe.edu) directly.

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ASSIGNMENTS & GRADING

READINGS AND PRE-CLASS ASSIGNMENTS
TWICE A WEEK — 15%

Reading is an essential part of this course. Reading before class is very important. Class time is to clarify your understanding and to work through additional applications and examples of the material. I will assume you have done your required readings in advance. With each reading I will provide a reading guide with information about what to focus on in the reading, as well as problems you should work through while completing the reading. **Anticipate spending 2 hours on each reading before class.**

MIDTERM EXAMS
TWO TIMES DURING SEMESTER — 30%

There will be two midterm exams during the semester. The exams will be self-scheduled in the library and open book. You are expected to use a hard copy of the text; if you have an electronic version a hard copy will be on reserve for you to use. The exams will be closed-note and you will have three hours to complete the exam. This format is designed to prepare students for the academic rigor of an engineering program or graduate study.

PROBLEM SETS
WEEKLY — 35%

The majority of learning in a theoretical physics class happens through the completion of problem sets. Problem sets are your opportunity to apply the concepts discussed in class, to synthesize ideas from across the semester and your entire academic career, and to practice mathematical and reasoning skills. Problem sets will take considerable time – you must start them early in order to be successful. **Anticipate spending at least 4 hours each week on the problem sets.**

FINAL PROJECT
INFREQUENT; SEE CALENDAR — 20%

The final project will be an opportunity for you to apply the concepts of statistical and thermal physics to a system of your choice. Through the project you will not only be able to explore a topic of your choice but will develop your science communication skills. The project will have multiple components including an oral presentation and final written report. Examples and details will be provided in separate documents on Canvas and discussed in class as the semester advances.

STRATEGIES FOR SUCCESS

Set aside specific time for class related work. Treat that time like you are actually in class. For a class like this you should plan to spend ~8-9 hours outside of class time on the course work each week.

Take handwritten notes during class and while reading the book. Information about how to effectively take notes from a physics text is available on Canvas.

Seek help with concepts during class meetings or office hours.

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Take care of your emotional, physical, and mental health.

Course Schedule

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Tuesdays		Thursdays	
8/30	Topic: Intro to class Reading: Preface, 1.1-1.4	**9/1**	Topic: Thermal Properties Reading: 1.5-1.6, 1.13, 2.1-2.5
9/6	Topic: Work, Heat, and Manipulating Systems Reading: 2.6-2.11 Due: Problem Set 1	**9/8**	Topic: Engines Reading: 2.12-2.14
9/13	Topic: Entropy Reading: 2.15-2.20 Due: Problem Set 2	**9/15**	Topic: Mathematics of Thermodynamics Reading: 2.21-2.24
9/20	Topic: Intro to Probability Reading: 3.1-3.4 Due: Problem Set 3	**9/22**	Topic: Continuous Probability Distributions Reading: 3.5-3.7
9/27	Review for Midterm Exam 1 *(Optional)* Due: Problem Set 4	**9/29**	**Midterm Exam 1**
10/4	Topic: Thermal Interactions Reading: 4.1-4.3	**10/6**	Topic: Canonical Ensemble Reading: 4.4-4.6
10/11	Topic: Grand Canonical Ensemble Reading: 4.7-4.9 Due: Problem Set 5	**10/13**	Topic: Statistical Simulations Reading: 4.9-4.11
10/18	**No Class (Fall Break)** **Due: Project Topic**	**10/20**	Topic: Magnetic Systems Reading: 5.1-5.5 Due: Problem Set 6
10/25	Topic: Magnetic Simulations Reading: 5.6-5.9	**10/27**	Topic: Ideal Gas Reading: 6.1-6.2, 6.7
11/1	Topic: Quantum Ideal Gas Reading: 6.3-6.6, 6.8 Due: Problem Set 7	**11/3**	Topic: Cool States of Matter Reading: 6.9-6.11
11/8	**No Class (Election Day)** **Due: Project Proposal**	**11/10**	Topic: Simulating Chemistry Reading: 7.1-7.2 Due: Problem Set 8
11/15	Topic: Phase Equilibria Reading: 7.3	**11/17**	Review for Midterm Exam 2 (*Optional*) Due: Problem Set 9
11/22	**Midterm Exam 2**	**11/24**	**No Class (T-Day)**
11/29	**In class research and project time**	**12/1**	**In class research and project time/presentation details**
12/6	**Presentation slide review** **Rough draft of paper due**	**12/8**	**Presentations during exam time** **Final paper due December 13.**