Modern Physics

Physics 0477, University of Pittsburgh *(Fall 2024)*

Syllabus – Version 3 – 2024-08-25

Course Information

Meeting Time: Mon, Wed 11:00 AM – 12:15 PM; Fri: 11:00–11:50 AM
Meeting Location: Thaw Hall 11

Instructor Information

- Lecturer: Prof. Michael Wood-Vasey, wmwv@pitt.edu
  Office Hours: Mon 1:00-3:00 pm.
  My office is Allen 320. We will move next door to Allen 319 or 321 if we need more space.
- There is a grader for this course, but direct all questions (in particular, complaints) to me.

Course Description

This is the third term of three-term sequence in university physics. This the first term of an honors-level two-term course in university physics. Previous familiarity with introductory mechanics, the basics of electromagnetism and waves, and calculus and basic linear algebra. Physics 0477 will provide introductions to quantum mechanics, atoms, statistical mechanics and thermodynamics, and special relativity.

Course Structure

Lectures (MWF) will be interspersed with short exercises and synchronous group work. Homework will be due weekly on Fridays. There will be 2 mid-term exams and a cumulative final.

- Before each lecture class (*including the first class*) you will be expected to complete:
  (1) Reading; (2) Video; (3) Concept Quiz

Logistics

Classes will be in person. If during the term you find yourself not able to attend in person for some number of days, please let me know and I will work together with you to come up with an effective plan to supplement your experience.

Grading

Percentage	Component
10%	Reading Quizzes
25%	Homework
10%	Homework Quizzes
15%	Midterm 1
15%	Midterm 2
25%	Final

Textbook, Videos, and References

1. REQUIRED: "Modern Physics with Modern Computational Methods", John C. Morrison, 3rd ed. Elsevier. ISBN 978-0-12-817790-7
2. REQUIRED (free): OpenSTAX, University Physics, Volume 2.
   https://openstax.org/books/university-physics-volume-1/
   This online textbook provides a good free reference of an introductory calculus-based intro physics mechanics course. We will also specifically use this text to discuss Thermodynamics, to supplement the presentation in Morrison. This textbook is available free through the website, as a PDF, or a Kindle ebook.
3. REQUIRED (free): "Special Relativity for the Enthusiastic Beginner", David Morin. Chapter 1. This first chapter of an overall great book on Special Relativity is available for free, courtesy of the author at:
   https://bpb-us-e1.wpmucdn.com/sites.harvard.edu/dist/0/550/files/2023/11/relativity_chap_1.pdf
   The full book is available in Kindle ($6) or print ($20) form, but that is not required for this course.
   https://davidmorin.physics.fas.harvard.edu/books/special-relativity/
4. Supplemental. Your Physiscs 174/175 (475/476) textbook for Thermodynamics, and a refresher.
5. I will provide videos to watch before most of lectures. These will be a combination of videos recorded by me and additional videos from different excellent sources on the web. Some of the YouTube channels I will be drawing from include

- Professor Dave Explains: Modern Physics playlist
  https://www.youtube.com/playlist?list=PLybg94GvOJ9FAFBqQGf5-4YbfKpWbJtGn
- 3Blue1Brown: Linear Algebra playlist
  We'll specifically assign the Eigenvalues + Eigenvectors video, but I encourage you to watch the rest if you're interested
  https://www.youtube.com/playlist?list=PLZHQObOWTQDPD3MizzM2xVFitgF8hE_ab
- Khan Academy: Fourier Series playlist
  https://www.youtube.com/playlist?list=PLH_Vuq97YgbcuEWn1q9iFfucAEynBUYpk
  You may have or come to develop your own favorite resources.

6. I may provide some additional supplemental readings during the semester. Read them.
7. We are fortunate to live in a rich, interconnected time in human history. There is a wealth of information available online about each of the topics we will cover. I encourage you to pursue additional materials, particularly on issues that you are having trouble understanding initially.

Reading assignments follow the schedule outlined in the Planned Calendar below.

Planned Calendar

Week of	Reading	Planned material	Calendar Notes
08/26	Chp. Intro,1	Particles & Waves	
09/02	Chp. 1,2	Duality; Schroedinger	*No class Monday, Sep 2*
09/09	Chp. 2	Schroedinger Equation	
09/16	Chp. 2,3	Schroedinger; Operators	
09/23	Chp. 3	Operators & Waves	*Exam 1, Wed, Sep 25*
09/30	Chp. 4	The Hydrogen Atom	
10/07	Chp. 4	The Hydrogen Atom	
10/14	Chp. 5	Many-Electron Atoms	*No class Monday, Oct 14*
10/21	Chp. 8	Statistical Mechanics	
10/28	Chp. 8	Statistical Mechanics	
11/04	OpenSTAX Chp 1-2	Thermodynamics	*Exam 2: Wed, Nov 6*
11/11	OpenSTAX Chp 3-4	Thermodynamics	
11/18	Chp. 12	Special Relativity	
11/25	—	—	*No class this week (Thanksgiving)*
12/02	Chp. 12	Special Relativity	
12/09	Chp. 12	Review	*Class only Monday*
12/11-12/17	FINAL EXAM	TBD	

Statistical Mechanics and Thermodynamics will also draw from the Physics 174/175 textbooks: HRK Chp 18–20 or OpenSTAX University Physics Volume 2, Chapters 1–4. https://openstax.org/details/books/university-physics-volume-2/

Participation: Reading, Videos, and Reading Quizzes

In this course you will be responsible for both your own and your colleagues's learning. Being prepared for class is a key part of aiding both your learning and that of the class.

To help you focus on being prepared for the material ahead of time, there will be Reading Quizzes due at 10:00am, one hour before each class day. The one hour is for me to read through and see what everyone understands well and where we should spend some more time. These are open-book, open-note; in fact, going back to the book to check on something again is sort of the point of many of the questions.

Read the book! Watch the videos! Take the reading quiz! One way in which you can assist your colleague's learning is to ask questions. If you are confused about something, you are almost definitely not alone; others will also be confused. Another key way is to fully participate in in-class interactive discussions and small-group discussions. You will be formally assessed on the reading quizzes, because that is the easiest thing to measure and record, but it represents the larger participation effort.

Homework

Homeworks will be graded on completeness, with one or two problems each week graded for correctness. Homework will be due Fridays at 5:00pm.

Each week you will complete a homework assignment that uses the material for the current week and builds on previous material. Assignments will be posted on Canvas. Completed homework, with your name and "Physics 477" clearly on the assignment, should be submitted through the "Homework" slot under the Physics Department mailboxes on the 1st floor of Allen Hall.

Working and discussion with classmates is very much encouraged, but solutions should be your own. Please list the names of your colleagues with whom you worked on each homework assignments. There is no particular credit assigned to such a list – this is for your own benefit to acknowledge credit and contributions.

Homework is an opportunity to develop your understanding of the course material. Be honest with yourself about whether or not you fully understand a problem. The quizzes and exams will test this.

Quizzes

There will be in-class quizzes approximately once/week. These will closed-note, closed-book quizzes on the homework from the previous week plus some simple questions on the for the current week. To prepare for the quizzes, (1) make sure you understand and can do all of the parts of the homework on your own; (2) do the reading for the current week.

Exams

There will be two mid-term exams during the semester plus a cumulative final.

The mid-term exams and final will be closed-book. You will be allowed to bring in notes on both sides of one regular-sized piece of paper. You will write your answers in the "blue books" that will be distributed along with the questions for the exam. You will be allowed calculators so that we can ask interesting real-life-inspired problems.

Exams and the Final will be graded on both correctness and completeness. Many questions will ask you to use sentences, diagrams, and equations to answer problems. You will lose points if you do not include all three methods to explain your answer.

You may turn in a new set of solutions for an exam for up to half credit on the points you missed. The new solutions must also include an explanation of what you were thinking in your original attempt and how you would explain to your past self what a correct approach and solution to the problem would be. These new solutions will be due a week after I return the graded exams to the class.

Final

There will be a cumulative final during finals week that will be worth 25% of the grade.

There will not be the same revision opportunity for the final exam as there will be for the mid-term exams.

Learning Objectives

Learning objectives are the list of things that you should be able to demonstrate that you can do by the end of this course. You might thus choose to call this section the "Study Outline". After completion of course students will be able to:

Course Objectives: Students successfully completing this course will be able to

1. Give relative space, time, and energy scales for macroscopic and microscopic systems. E.g., planets, people, cells, molecules, atoms, nuclei, and fundamental particles.
2. Solve the Schroedinger equation for simple 1 dimensional systems
3. Solve simple problems in multidimensional systems including the hydrogen atom.
4. Describe how energy levels are filled by Fermions and Bosons, and explain features of the periodic table.
5. Solve basic problems in thermodynamics and statistical mechanics.
6. Calculate changes in position and time between different inertial reference frames.
7. Calculate kinematic invariants in special relativity.

Acknowledgments

Attribution and credit is the core currency of respect and recognition in science.

The structure, lectures, assignments and other material in this course are based on an extensive history of physics education over the past 100 years, with roots extending beyond that. More specifically, I've benefitted in my preparation from previous editions of this course taught by Prof. Jim Mueller.

Similarly, please credit your colleagues with whom you discuss and work with on homework.

Disabilities

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and the Office of Disability Resources and Services, drsrecep@pitt.edu, 140 William Pitt Union, 412-648-7890, or (412) 228-5347 for P3 ASL, as early as possible in the term. Disability Resources and Services will verify your disability and determine reasonable accommodations for this course.

Email and Canvas Communication Policy

Each student is issued a University email address (username@pitt.edu) upon admittance. This email address may be used by the University for official communication with students. Students are expected to read email sent to this account on a regular basis. Failure to read and react to University communications in a timely manner does not absolve the student from knowing and complying with the content of the communications. The University provides an email forwarding service that allows students to read their email via other service providers (e.g., AOL[**], GMail, Hotmail, Yahoo). Students that choose to forward their email from their pitt.edu address to another address do so at their own risk. If email is lost as a result of forwarding, it does not absolve the student from responding to official communications sent to their University email address. To forward email sent to your University account, go to https://accounts.pitt.edu, log into your account, click on Edit Forwarding Addresses, and follow the instructions on the page. Be sure to log out of your account when you have finished. (For the full email Communication Policy, go to https://www.bc.pitt.edu/policies/policy/09/09-10-01.html.)

You are responsible for following announcements on Canvas. By default these are sent to your Pitt email account. If you choose to change these notification settings, you remain responsible for understanding the content in Canvas notifications in a timely manner.

[**] Once upon a time there was this company that would send CDs to your house every other week to get you sign up to use a phone line to connect your computer to get your email and look at cat pictures that people had sent you. This was back when phones had cords and sentences had two spaces between them. They were then bought by Time Warner. Now everyone is sad. This all happened before you were born.

Academic Integrity

Cheating/plagiarism will not be tolerated. Students suspected of violating the University of Pittsburgh Policy on Academic Integrity, noted below, will be required to participate in the outlined procedural process as initiated by the instructor. A minimum sanction of a zero score for the quiz, exam or paper will be imposed. For the full Academic Integrity policy, please see https://www.provost.pitt.edu/info/ai1.html

Code of Conduct

Communication is key to a productive learning environment, and we can maintain productive communication by exhibiting respect for one another. The success of the course for yourself and others depends on all of our commitment to behavior that demonstrates respect for differences, understanding towards others and a willingness to listen and learn.

The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, see: https://diversity.pitt.edu/affirmative-action/policies-procedures-and-practices.

Use of Class Recordings

Course meetings may be recorded by the instructor for the benefit of students who are not able to participate synchronously. Any such recordings are not to be used or distributed outside the context of this course.