PH2400 Univ. Physics IV: Waves/Modern Physics Summer 2025

Instructor Information

Instructor: Dr. Katrina Black
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Office: Fisher 114
Office Hours: On Zoom, typically Thursdays 2-3 pm EDT and Mondays 6-7 pm EDT. See Canvas Home Page for Zoom link. Please email if you prefer an in-person meeting or need to meet at an alternate time.

Course Materials

1. Required Text: Modern Physics for Scientists and Engineers, 5th Edition, by Thornton, Rex, and Hood. ISBN 978-1337919456. An e-text is available via Inclusive Access, or you can opt out of IA by July 2 and purchase a physical copy.
2. I highly recommend a graphing calculator.
3. Computer and high speed internet sufficient for streaming video, accessing course materials, etc. Most students will want access every weekday.
4. Webcam or phone with camera for Zoom proctoring of exams.

Course Overview

In PH2400, we will explore wave-particle duality, atomic models and spectroscopy, solutions to Schrodinger's equation in 1 and 3 dimensions, nuclear structure and decay, and special relativity. Differential and integral calculus is required.

By the end of this course, successful students should be able to:

1. Describe fundamental or pioneering experiments in modern physics and explain how the experiment showed the need for a change in our description of the physical world or verified an existing theoretical model.
2. Create solutions to typical modern physics problems.

Vital Course Information

1. **Time Commitment:** This summer course is very intense – we cover a semester's worth of physics in only 7 weeks. Expect to spend around 20 hours per week on this course. Many students find it takes even more time during more difficult material.
2. **Ask for help when you need it:** In an online course, it's up to you to seek help when you need it. Unlike in a synchronous environment, I can't see when you look confused! It's my job to help you learn this material, so please don't hesitate to be in touch with me and your classmates early and often. Make use of our class Discussions!
3. **Not Entirely Self-Paced:** Assignments will be due each weekday and exams are scheduled for specific days. Each week's material will open on the prior Wednesday and you are welcome to work ahead to accommodate your schedule.
4. **Exams Must Be Proctored:** I will proctor your exams via Zoom - as each exam approaches, we will determine mutually agreeable time slot(s) as a class.

Grading Policy

Your final grade will be determined using the following weights:

Assignment Group	Percentage
Daily Quizzes	20%
Written Homework	20%
Reflect/Forum Participation	10%
Midterms	30% (15% each)
Final Exam	20%

Letter grades will be assigned as follows, rounded to the nearest percent:

Grade	Range
A	90-100%
AB	85-89%
B	80-84%
BC	75-79%
C	70-74%
CD	65-69%
D	55-64%
F	0-54%

I reserve the right to adjust these ranges downward (to increase final letter grades), but will not adjust them upward.

Course Components and Work Schedule

In order to accommodate varying student schedules, our work weeks will start on Tuesdays. Each Tuesday through Friday introduces new material, typically broken into two parts (a and b). Mondays are set aside to review and wrap up the weekly written homework. As you work through each weekly Module, you will find four types of work associated with each day of new material.

- Work through the *Reading, Video, and Activities (RVA)* pages
- Take the *Daily Quizzes*
- Think about the *Weekly Homework*
- *Reflect* on your learning

Reading, Video, and Activities (RVA) pages: These pages connect you to the associated parts of your textbook and contain a variety of materials to help you apply what you have read, including explanatory videos, online activities and simulations, and skill-building practice quizzes.

Daily Quizzes: Daily "quizzes" check that you understood the fundamental ideas from each RVA page and give you practice in the ideas you will use in the homework. If you have trouble with the quizzes, you will want to review the reading, video, and activities, or ask for help in our class discussion - you

have ten tries to get these questions right! Two daily quizzes will be dropped to allow for any technical issues.

Try the Homework: I recommend looking over the homework immediately after completing the day's RVA and Quizzes to identify and think about how to approach problems related to that day's material, but you don't have to finish the problems then! Instead, think about how you might solve each problem based on what you have just learned. Make a plan and start work on each problem.

Reflect on your learning: There will be several Discussions available through the course. Daily Discussions invite you to reflect on that day's new material and how it connects to what you have already learned. Weekly Homework Discussions allow collaboration on homework problems. Exam Discussions provide an organized space for exam prep. Because there are 24 days of new material, I expect that each student contributes at least 24 times over the course. One way to do this is to post to each Daily Discussion, but can also earn points by asking and answering questions in the Homework and Exam Discussions. You can earn extra credit in the portion of the course, up to a total of 36/24, or 150%.

Finish the homework: The written homework related to each week's material is due at the end of the week (Mondays at 11:59 pm), except for the last week of class.

Late Work and the Grace Period

I know everyone is busy, especially during a compressed summer class! Canvas and Gradescope will automatically apply a 12-hour grace period for every assignment. After the grace period, the assignments will lock. *Please use the grace period responsibly and only when needed so that I can continue to offer it.* Otherwise, late work will only be accepted for reasons consist with the Dean of Students' excused absence policy.

Exams

This course has two midterms and one final exam. The scheduled dates are:

- Midterm 1: Wednesday, July 9 (Chapters 1-3)
- Midterm 2: Wednesday, July 23 (Chapters 4-6)
- Final Exam: Friday, August 8 (Comprehensive with focus on Chapters 7, 8, 10 - 13)

Exams for this course are hybrid computer/paper exams. The exams will be presented online, but some questions will require written work to be uploaded via photograph or scan.

Please allow 90 minutes for your midterm exams and 120 minutes for your final exam.

Exams are open book/open notes/open course. You may use the resources available in the Canvas course, but you may not use the open internet to look up how to do a problem. Calculators are allowed. I (or a TA) will proctor your exams via Zoom. Exams will only be available during specific time slots the day of the exam, which will be mutually determined based on instructor and student availability.

Academic Integrity

I have a liberal policy toward students working together to solve homework problems. Just as physicists work together to do physics, physics students should work together to understand homework problems! You can work together in person, or ask and answer questions in Discussions threads. HOWEVER, do not short-change yourself by using another student's work to answer quizzes and homework questions. Not only is this a breach of academic integrity, but doing homework is like practicing for a recital or training for a marathon. You may find a way to cut corners, but your exam grades will show it!

Of course, during an individual examination, any communication with any other person or use of unauthorized resources is considered cheating.

If academic dishonesty is suspected, the matter will be referred to the Office of Student Affairs. The penalty is no less than an academic integrity warning and no more than expulsion.

University Policies

Student work products (exams, essays, projects, etc.) may be used for purposes of university, program, or course assessment. All work used for assessment purposes will not include any individual student identification.

Michigan Tech has standard policies on academic misconduct and complies with all federal and state laws and regulations regarding discrimination, including the Americans with Disabilities Act of 1990. For more information about reasonable accommodation for or equal access to education or services at Michigan Tech, please call the Dean of Students Office at (906) 487- 2212, email deanofstudents@mtu.edu, or view the policies here.

If you require disability accommodation for any reason, please don't hesitate to contact me or the Dean of Students for guidance. Visiting students should be aware that according to Michigan Tech University guidelines, disability accommodations should be verified through the Dean of Students Office.

Tentative Schedule

Week	Day	Date	Reading	Topic
0	Mon	23-Jun	in Canvas	Course Introduction
1	Tue	24-Jun	Ch. 1; 2.4	Development of special relativity; the Lorenz Transform
	Wed	25-Jun	2.5	Time dilation and length contraction
	Thu	26-Jun	2.6 - 2.9	Addition of velocities; "paradoxes" in relativity
	Fri	27-Jun	2.11 - 2.13	Relativistic energy and momentum; calcs in modern physics
	Mon	30-Jun		Week 1 HW due
2	Tue	1-Jul	in Canvas	Review of oscillators and waves; Diffraction and superposition
	Wed	2-Jul	in Canvas; 3.1 - 3.5	Wave-like nature of light; atomic spectra and blackbody radiation
	Thu	3-Jul	3.6 - 3.9	Photoelectric effect; Compton effect, and Bremsstrahlung radiation
	Fri	4-Jul		*Independence Day Recess*
	Mon	7-Jul		Week 2 HW Due
3	Tue	8-Jul	Chapter 4	History of Atomic Models; Bohr Model
	Wed	9-Jul		**Midterm Exam 1: [Chapters 1-3]**
	Thu	10-Jul	5.1 - 5.4	Scattering; de Broglie wavelength; wave packets
	Fri	11-Jul	5.5 - 5.6	Two-slit electron diffraction; Heisenburg Uncertainty Principle
	Mon	14-Jul		Week 3 HW Due
4	Tue	15-Jul	5.7 - 5.8, 6.1	Born Interpretation; Wave function of a free particle
	Wed	16-Jul	6.3 - 6.4	Finite and infinite square wells
	Thu	17-Jul	6.2, 6.6	Quantum Harmonic Oscillator; Expectation values and operators
	Fri	18-Jul	6.7	Potential Barriers and Tunneling
	Mon	21-Jul		Week 4 HW Due
5	Tue	22-Jul	6.5; 7.1 - 7.3	Solutions to the Schrodinger Equation in 3D
	Wed	23-Jul		**Midterm Exam 2: [Chapters 4-6]**
	Thu	24-Jul	7.4 - 7.6	Hydrogen atom, Zeeman effect, selection rules
	Fri	25-Jul	Chapter 8	Atomic Structure; L-S coupling and anomalous Zeeman effect
	Mon	28-Jul		Week 5 HW Due
6	Tue	29-Jul	Chapter 12	Nuclear Structure and Radioactive Decay
	Wed	30-Jul	13.1 - 13.7	Nuclear Reactions, Fission, and Fusion
	Thu	31-Jul	10.1-10.2; 10.5-10.6	Molecular Bonding and Spectra; Lasers
	Fri	1-Aug	11.1 - 11.3	Band Theory; Semiconductor Applications
	Mon	4-Aug		Week 6 HW due
7	Tue	5-Aug	Chapter 14	Special Topics: Particle Physics
	Wed	6-Aug	15.3 - 15.6	Special Topics: Gravitational Waves and General Relativity
	Thu	7-Aug		Study Day
	Fri	8-Aug		**Final Exam [Comprehensive with a focus on Chapters 7, 8, 10 - 13]**