PH-214-B Physics III: Optics & Modern Physics

Spring 2025 Syllabus

Course Information

Credits:	3 credits (3 contact hours per week)
Prerequisites:	PH-213 (Waves & E&M), MA-223 (Vector Calculus)
Meeting times:	Tuesdays 2:00PM-3:50PM 41 Cooper Square, Room **504** Wednesdays 10:00AM-10:50AM 41 Cooper Square, Room **504**
Instructor:	Dr. Brittany Corn-Agostini brittany.corn@cooper.edu Office: 41CS Room 413
Office Hours:	*To be decided after the first week of semester*
Communication:	All course announcements will be posted on **Teams**. It is recommended that you configure your Teams notifications for this course so that you receive all announcements in a timely manner. To communicate with me directly outside of lecture and office hours, you may message me on Teams chat between the hours of 7am-8pm otherwise via email anytime.

Course Description

This course sets out to explore the interaction between light and matter. We will begin with a classical analysis, applying Maxwell's Equations to gain an understanding of physical optics and electromagnetism in materials. This will lead us to study the groundbreaking experiments from the 20th century that dramatically changed our understanding of the laws of physics. It will be revealed that new physical laws beyond classical physics were needed to truly describe the interaction between light and matter, known as quantum mechanics. We will venture into the quantum realm, where the fundamental units of matter and energy exhibit both wave-like and particle-like behaviors and the unprecedented laws of quantum physics that come along with it.

Course Objectives

[ABET outcome criteria: 1,2,4,6 & 7]

The intended goal of the course structure outlined in this syllabus is for you walk away with the following skillset:

- Understand how the basic principles of optics arise from the interaction of electromagnetic waves and matter, as well as where this model fails as a result of quantum and/or relativistic effects.
- The ability to solve Maxwell's equations for wave-like behavior in several of these situations and understand the content and significance of the major experiments that ushered in quantum mechanics.
- The ability to solve fundamental energy state problems for models of quantum systems and analyze and interpret the results.
- Apply advanced mathematical skills from vector calculus and linear algebra that result in physically accurate outcomes.
- Ability to assess boundary conditions and under what limits certain theories are valid

Textbook & Course Materials

All course materials and assignments will be posted to **Teams**. Selections from the following textbooks will be provided as PDFs on our Teams channel:

- E&M/Optics: Griffiths, Purcell, Hecht, and Bekefi & Barrett
- Modern/Quantum: Griffiths, Gasiorowicz, and Liboff

Course Topics & Schedule:

The course will be broken down into the following key Units. A detailed course schedule will be provided within the first two weeks of lecture and then posted to Teams.

Topics	Approx. Timing
Unit 1: EM Waves • Vector calc review • Maxwell's Equations in differential form • EM radiation as plane waves	Weeks 1& 2 *[4 lectures]*
Unit 2: Radiation & Scattering • Thompson Radiation model; Larmor Power • Thompson scattering (Ex: Corona of the sun) • Rayleigh Scattering (Ex: in Earth's atmosphere)	Weeks 3-4 *[3 lectures]*
Unit 3: Optics • **Unit 3A:** Maxwell's Equations in Dielectric and Magnetic Matter • **Unit 3B:** EM Propagation in material, Fresnel formulae, Reflection, Transmission, TIR, Brewster	Weeks 5-8 *[5 lectures]*
Midterm Exam	Week 10
Unit 4: Modern Physics • Blackbody Radiation • Photoelectric Effect • Wave-Particle Duality • Probability interpretation and Wavefunctions	Weeks 8,10-11 *[4 lectures]*
Unit 5: Quantum Mechanics • Schrodinger's Equation • Quantum Mechanical Operators: eigenfunctions, eigenvalues, and observables • 1D and 2D energy state problems, normalization • Hydrogen atom, Pauli exclusion principle, spin	Weeks 12-15 *[8 lectures]*
Project Presentations Student presentations of impactful applications of the theory presented in lecture	Week 16 & 17 *[2 lectures]*
Final Exam	Week 17

Course Policies

The following course policies outline my expectations of student performance throughout the course. **Please note: Any announcements made in class, via email, or in Teams take precedence over the information provided here.]

Attendance, behavior, and make-up policy:

- While attendance will not count toward your grade, it is encouraged that you attend all meetings, read all required texts, and work through course materials thoroughly outside of class. It is your responsibility to address any gaps in your understanding via the many resources available to you (i.e., office hours and peer tutoring).
- I strive to maintain an environment where all students can engage, share their unique thoughts, and feel respected. Offensive, discouraging, or disrespectful language of any kind will not be tolerated in the classroom. Always bring a curious and inquisitive mindset to class!
- **Important note on quiz or exam absences:** There are very few legitimate reasons to miss a quiz or exam and they are typically very rare. If you are in a true emergency situation and cannot attend the exam, you must communicate it immediately both to me and to the Director of Student Care, Alex Fischer. You will need to provide some form of documentation to the Student Care team, who will verify your specific circumstances and then communicate to me and your other professors the confirmation. Without this step, your absence will be considered "unexcused" and you will not be permitted to make up the quiz or exam, resulting in a zero grade.

Weekly HW [worth 15% of grade]

- Weekly homework assignments are designed to be a low-stakes way for you to reflect on all lecture materials covered that week and develop an understanding in your own words.
- You are encouraged to work together with your peers and have open conversations to digest the full scope of the theories presented. *However, each student must submit their own unique work in their own words.*
- Possible questions could consist of (but are not limited to): summarizing the assumptions and conclusions of a particular model; completing a derivation; scenario analysis; plotting & visualizing results of a model; researching relevant applications.
- Problem sets will be graded only for completeness on a scale of 2 points:
    - [2 points] – Adequately completed all assigned questions
    - [1 point] – Partially completed assignment (*You are encouraged to hand in what you have)*
    - [0 points] – Missing or unsatisfactory work.
- No late problem sets will be accepted under any circumstances, as solutions will be posted promptly.

Quizzes [worth 25% of grade]

Each unit will have a short, in-class, timed quiz. You will be allowed to bring a hand-written reference sheet and a scientific calculator (not graphing) to the quiz. Keeping up with class lectures, readings, and homeworks will be the best way to prepare for quizzes.

Exams [worth 50% of grade]

The midterm and final exam, each worth 25% of your grade will assess the students ability to apply your broad knowledge of all unit topics.

Project Presentation [worth 10% of grade]

The project offers students the opportunity to explore impactful applications of the theory presented in lecture. Research will involve studying the theoretical background, technical setup, and significance of the applications. Students are required to present their findings in a PowerPoint presentation at the end of semester. More details on the expectations and suggested topics will be provided throughout the semester.

Final Course Grade Calculation:

Letter grades at the end of the course will typically follow the below breakdown of percentiles, however I will also typically analyze the class average, μ, and standard deviation, σ, to see where your grade, x, falls within the class distribution when deciding the final letter grade. Any curving will be at my discretion.

Final grade ≥90%			A	Outstanding performance
Final grade ≥80%	or	$(x-\mu) \geq 0$	B	Above average performance
Final grade ≥70%	or	$-1\sigma \leq (x-\mu) < 0$	C	Requirements satisfactorily competed
Final grade ≥60%	or	$-1.5\sigma \leq (x-\mu) < -1\sigma$	D	Passing but unsatisfactory
Final grade <60%	or	$(x-\mu) < -1.5\sigma$	F	Failure to meet minimum requirements

Academic Honesty & Collaboration

It is highly encouraged to discuss classwork and HW assignments amongst your peers. However, your final submitted work on all assignments and especially on all in-person assessments must *always* be *entirely your own*. Plagiarism and academic dishonesty of any kind is not acceptable and if witnessed will result in ***all participants being reported to the Dean's Office***. The Deans will then assess the incident and decide on the final resolution.

Some examples of academic dishonesty include (and are not limited to):

- Plagiarism from another individual or from an electronic device.
- Obtaining access to materials not permitted for use on a quiz or exam
- Obtaining solutions in advance for any graded work
- Use of AI, such as ChatGPT or other tools, to solve any part of an assignment, unless requested specifically to do so.
- Discussing contents of a test with an individual before they have taken it

On every Quiz or Exam, you will be expected to sign the following honor pledge:

"I affirm that I will not give or receive any unauthorized help on this assessment, and that all work will be completely my own."

Be sure to make yourself fully aware of The Cooper Union School of Engineering Policy on Academic Integrity: https://cooper.edu/engineering/curriculum/academic-standards-regulations

Accommodations

I support and strive to maintain an environment where all students can engage. Students with disabilities or who are in need of special accommodations for this class should first notify the Dean of Students who will issue a letter detailing the accommodations the student is eligible to receive. You will then meet with me to discuss options for meeting those accommodations. It is the student's responsibility to reach out each time an accommodation is needed and will not be automatically assumed for every assignment throughout the semester unless requested to do so. You must notify me in writing at least two weeks before the accommodations are needed, including proposed timing. The full disability support services for students are described here: https://cooper.edu/students/student-affairs/disability

Core Values

I try to create course policies that support a fair and equitable classroom and set high performance standards for all students. I hope to create an inclusive learning environment where you feel both challenged but also constantly respected and recognized within the course. Please make an appointment with me if you are having any issues related to me, the course, or your fellow students.

While I want you to feel comfortable coming to me with issues you may be struggling with or concerns you have, please be aware that I have reporting requirements that are part of my responsibilities as a member of the faculty. If you inform me of an issue of sexual harassment, sexual assault, or discrimination, I will keep the information as private as I can, but I am required to report the basic facts of the incident to Cooper's Title IX Coordinator. The Cooper Union Title IX policy on sexual misconduct can be found here:
https://cooper.edu/sites/default/files/uploads/assets/site/files/2020/Cooper-Union-Policy-Upholding-Human-Rights-Title-IX-Protections.pdf

Counseling Services at The Cooper Union are coordinated through the Office of Student Affairs. The Cooper Union counseling and mental health services website can be found here https://cooper.edu/students/student-affairs/health/counseling