# PHY-203: OPTICS AND MODERN PHYSICS

**Effective Term**
Fall 2026

**BOT Approval Date**
12/11/2025

**Discipline**
PHY - Physics
**Course Number**
203

**Course Title**
Optics and Modern Physics

**Short Title**
Optics & Modern Physics

**Credit Status (CB 04)**
D - Credit - Degree applicable

## Units

**Lecture Units**
3.00

**Lab Units**
1.00

**Total Units**
4.00

## Hours

**Lecture Contact Hours**
48-54
**Out of Class Hours Lecture**
96-108

**Lab Contact Hours**
48-54
**Out of Class Hours Lab**
0.00

**Total Contact Hours**
96 - 108

**Total Out of Class Hours**
96 - 108

**Total Student Learning Hours**
192 - 216

**Is this an existing Extensive Lab?**
No

**Do you want to propose this for Extensive Lab?**
Yes

**Distance Education**
Yes

## Distance Education

**Distance Education Type**
Hybrid Only

**What will be done in face-to-face meetings**
Laboratory experiments will take place during face-to-face meetings. Exams and quizzes will be completed face-to-face. Other activities will be done as well, such as working example problems.

**Are you using publisher content?**
No

**Regular Substantive Interaction**
Instructor-to-student, student-to-student, and student-to-content contact shall be distributed in a manner that will ensure regular substantive interaction (RSI) is maintained not only weekly but also for the duration of the course. Instructor interactions should be equivalent in time, quality and consistency to the engagement students would receive in a face-to-face course—for example, through announcements, discussion participation, personalized feedback, video messages, or other instructional communications. Instructors are expected to be responsive to student inquiries within a 24-72 hour time frame excluding holidays. RSI will be maintained through a variety of methods: • Orientation - Students must be oriented to the online and face-to-face portions at the start of the course. • Announcements - Announcements using the course management system must be posted at least weekly to keep students current on course events, due dates, materials, etc. • Discussion Forums - Content-related discussion forums within the designated CMS will include appropriate instructor participation and will be initiated and maintained, with timely feedback provided. Instructors are required to monitor the discussions and related activities to provide guidance and direction. Open-ended discussion boards may be used to further learning and interaction. • MSJC Communication – Instructor will use MSJC-administered communication tools (such as email or the designated CMS communication tools) to regularly communicate with and provide ease of access to students. • Timely Feedback - Timely feedback on student work will be provided by the instructor, which may include comments and/or rubrics, within the Grades area of the designated CMS. • Scheduled Meetings – Hybrid and synchronous courses will meet at regularly scheduled times. ADA Compliance - All course interactions and content must be designed with accessibility in mind and meet ADA requirements.

**C-ID (Admin Only)**
C-ID PHYS 215

**Catalog Description**
This course is a calculus based study of optics and modern physics. Subjects covered include Optics, Relativity, Quantum Physics, Atomic Physics, Nuclear Physics and Particle Physics.

## Requisites

**Prerequisite(s)**

| Prerequisite(s) (must be taken before) |
| --- |
| PHY-202 (with a grade of C or better) |
| and MATH-213 (with a grade of C or better). |

## Codes

**TOP Code (CB 03)**
1902.00 - Physics, General

**CIP Code**
40.0801 - Physics, General.

**Repeatability Code**
No

**Grading Option**
Letter grade OR P/NP

**Minimum Qualifications**

| Minimum Qualifications | And/Or |
|---|---|
| Physics/Astronomy (Masters Required) | End |

## GE Information

**Check GE Types Requested**
AA/AS A - Natural and Physical Sciences

## Cal-GETC Areas

**Approved Cal-GETC Area**
AREA-5A

**Approved Second Cal-GETC Area**
AREA-5C

## Learning Objectives

**Learning Objectives**

| Learning Objective |
|---|
| 1. Communicate verbally, diagrammatically and/or mathematically the fundamental principles of optics, relativity, quantum physics, nuclear and particle physics and apply them in the analysis of the corresponding physical systems. |
| 2. Analyze and solve a variety of problems utilizing verbal, diagramming and mathematical articulation techniques in the following topics: a. Geometrical and Physical Optics b. Special Relativity c. Quantum Physics d. Atomic and Nuclear Physics e. Particle Physics |
| 3. Utilizing basic measuring tools: meter stick, timer and calipers, set-up, measure and record measurements. Utilizing computer-based data acquisition systems, set-up, measure and record measurements. |
| 4. Analyze and interpret laboratory data using calculator and computer based analytic and graphing applications as required. |
| 5. Analyze and interpret the error in measurements and calculations, determine how to reduce this error in producing more accurate results. |
| 6. Produce clear and comprehensive laboratory reports utilizing these standard components when possible; Name, Title, Purpose, Materials, Diagram, Data Acquisition, Data and Error Analysis, Discussion and Conclusion. |
| 7. Demonstrate an understanding of the contributions made to the physical sciences by members of underrepresented groups and evaluate the challenges they had to overcome. |

## Learning Outcome Information

**Course Learning Outcomes**

| Learning Outcome |
|---|
| 1. The student will utilize the object-image relation in order to determine the path of a ray of light reflected off of a spherical mirror. |
| 2. The student will apply the Born rule in order to determine the probability of finding an electron in a region of space. |
| 3. The student will compute the binding energy of the nucleus of various isotopes and use it to determine the energy released when a Uranium atom undergoes fission. |

## Content

**Course Lecture Content**

1. Optics:
    a. Geometrical Optics
        i. Ray Model in Geometrical Optics
        ii. Reflection and Refraction of Light

    iii. Dispersion of Light
    iv. Huygen's Principle
    v. Image Formation by Mirrors and Lenses
    vi. Thin Lenses
  b. Physical Optics
    i. Young's Double Slit Experiment
    ii. Interference in Light Waves
    iii. Interference in Thin Films
    iv. Diffraction of Light
2. Relativity
  a. Special Relativity
    i. Michelson - Morley Experiment
    ii. Einstein's Postulates
    iii. Time Dilation and Length Contraction
    iv. Lorentz Transformation
    v. Relativistic Momentum and Energy
  b. General Relativity
    i. Principle of Equivalence
    ii. Gravitation: Newton vs Einstein
    iii. Time Dilation and Gravitational Red Shift
    iv. Black Holes
    v. Gravity Waves
3. Quantum Physics
  a. Historical development
    i. Blackbody Radiation and Planck's Theory
    ii. Correspondence Principle
    iii. The Photoelectric Effect
    iv. The Compton Effect
  b. Particle – Wave Duality
  c. The Uncertainty Principle
  d. Particle in a Box
  e. Schrödinger's Equation
  f. Particle in a Box Revisited
  g. Simple Harmonic Oscillator
  h. Quantum Tunneling
4. Atomic Physics
  a. Early Models of the Atom
  b. The Hydrogen Spectrum and Bohr's Model of Hydrogen
  c. de Broglie Waves and the Bohr Model
  d. The Wave Functions for Hydrogen
  e. The Quantum Numbers and Their Physical Interpretation
  f. Pauli's Exclusion Principle and the Periodic Table
  g. Atomic Spectra: Visible and X-Ray
5. Nuclear Physics
  a. Properties and Structure of Nuclei
  b. Radioactivity
  c. Nuclear Binding Energy
  d. Radioactivity
  e. Nuclear Fission and Fusion
  f. Lise Meitner and her experience as a Jewish woman in Nazi Germany and how her work on nuclear fission was suppressed and downplayed long after the end of WW2.
  g. Marie Curie's inability to register at university due to being a women and her education at the "Flying University"
6. Particle Physics
  a. The Fundamental Forces of Nature
  b. Antiparticles

   c. Classification of Particles
   d. Quarks
   e. The Standard Model Cosmology

**Course Lab Content**

1. Ray diagrams.
2. Reflection & Refraction
   a. Prisms.
   b. Lenses.
   c. Optical instruments
3. Diffraction/Interference/Polarization.
   a. Finding the wavelength of a Laser using Diffraction Grating.
   b. Examining the Interference pattern associated with a Diffraction grating.
   c. Finding the polarization of a Laser.
4. Spectral Analysis.
5. Davisson Germer Experiment
6. Calculation of Planck's Constant
7. Photoelectric Effect.
8. Double Slit Experiment (Interference).
9. Lasers.
10. Radioactivity I. Geiger-Müller (GM) tubes.
11. Radioactivity II. Measuring the Activity of different radioactive sources.
12. Cosmic Rays (Bubble Chamber)

## Methods of Instruction

**Method**

Directed Study

**Integration**

Utilizing small student groups students will be guided through the problem-solving process demonstrating verbal, diagraming and mathematical articulation of the fundamental principles of optics, relativity, quantum physics, nuclear and particle physics and apply them in the analysis of the corresponding physical systems. Utilizing small student groups students will be guided through the problem-solving process demonstrating analysis and solve a variety of problems utilizing verbal, diagramming and mathematical articulation techniques in the fundamental principles of optics, relativity, quantum physics, nuclear and particle physics.

**DE Adaptations for MOI**

The discussion board in the course management system should be utilized for interactive and accessible discussions on the content of the course lectures, media, homework and other topics including current research and discoveries. Time should be set aside every two weeks in face-to-face meetings in order to interactively work examples; employing the Socratic method to encourage engagement, or having students work in groups to solve problems.

---

**Method**

Lab Activities

**Integration**

Performing experiments reinforces the learning experience for all students. Students will demonstrate their ability to set up an experiment, use measuring tools and computer software to gather and report experimental data. Students will produce clear formatted lab reports, explain in written form the physics concepts involved, determine the right mathematical formulation, analyze their error, and discuss their results.

**DE Adaptations for MOI**

The lab activities will be a required face-to-face activity, and therefore will not need adaptations for DE.

---

**Method**

Lecture

**Integration**

Instructor will demonstrate verbally, diagrammatically and mathematically the fundamental principles of optics, relativity, quantum physics, nuclear and particle physics and apply them in the analysis of the corresponding physical systems. The Instructor will demonstrate a variety of problem-solving techniques utilizing verbal, diagrammatic and mathematical articulation techniques in the fundamental principles of optics, relativity, quantum physics, nuclear and particle physics.

**DE Adaptations for MOI**

Recorded, accessible videos of lectures will be provided in course management system. Furthermore, live lectures can be utilized in the CMS in order to facilitate interaction between students and faculty.

---

**Method**

Discussion

**Integration**

Students will participate in a discussion in the course management system about media viewed in class regarding the struggles and contributions made by underrepresented groups.

**DE Adaptations for MOI**

There is no adaptation needed here since the discussion occurs in the CMS. In the case that media is shown in the CMS, it must be made accessible.

---

## Methods of Evaluation

**Method**

Exams/Tests

**Integration**

Exams and quizzes will be administered to provide feedback to students about their progress. Exams are important for students to stay on target and move forward in their physics development. Exams will be evaluated based upon our Learning outcomes of articulation of the physics concepts. Students will demonstrate their ability to draw a diagram and label all parameters, derive mathematical relationships toward solving the problem. There should be 4 exams given throughout the course.

**DE Adaptations for MOE**

Exams must be completed in person, in the weekly face-to-face meetings, so no adaptations are needed.

---

**Method**

Homework

**Integration**

Students are both required and encourages to solve as many problems as they can for each topic area. Problem-solving in physics is a skill that is both required and useful in Engineering, Computer Science and every STEM field. Students will be evaluated on their ability to articulate their problem solution via a diagram, mathematical reasoning and verbal (written) reasoning. Problems can either be assigned out of the textbook, be written by faculty members or chosen from physics question banks. The instructor can require problems to be handed in to be graded by hand, or embed an open source homework application in the CMS..

**DE Adaptations for MOE**

This MOE remains the same for DE, so no adaptation is needed here.

---

**Method**

Papers

**Integration**

Students will be evaluated on their performance in Laboratory activities. Students will be evaluated on their ability to set-up the experiment, measure and record data. Students will be evaluated on their standard formatted lab writeup, including data acquisition, data analysis, error analysis and conclusion. Students will be evaluated on their explanation of the physics concepts and derivation of the mathematical foundation of the lab exercise.

**DE Adaptations for MOE**

The lab activities will take place during the face-to-face portion of the course, therefore no adaptations are needed.

---

**Method**

Class Participation

**Integration**

We will have a class discussion about the impact of underrepresented groups on the physics body of knowledge, or the impact of discrimination. This can be an in class discussion, or a discussion in the CMS. Students will could be graded for participation in the discussion, or they could be asked to submit a written response.

**DE Adaptations for MOE**

In the case of the hybrid course where classroom time is limited, a discussion can be set up in the CMS and can be graded either automatically for completion or individually via the instructor grading function.

---

## Assignments

**Assignment Type**

Writing

**In-class and/or outside of class**

Outside of class

**Formative or Summative**

Formative

**Assignment**

A Young's interference experiment is performed with monochromatic light. The separation between the slits is 0.500 mm, and the interference pattern on a screen 3.30 m away shows the first side maximum 3.40 mm from the center of the pattern. What is the wavelength? An electron has a kinetic energy five times greater than its rest energy. a) Find its total energy and b) its speed.

**How assignment will be adapted in online format**

These are homework problems assigned from the course textbook that students are meant to complete outside of class, therefore no adaptation is needed.

---

**Assignment Type**

Reading

**In-class and/or outside of class**

Outside of class

**Formative or Summative**

Formative

**Assignment**

Read Chapter 8, Section 1 on the hydrogen atom. Pay particular attention to the part explaining how to use the wave function to make predictions, and make sure you understand equations 8.9 through 8.12. As you read, consider how the radial probability density function relates to Figure 8.9, and how these relate to where we would be most likely to find an electron in a hydrogen atom in its ground state.

**How assignment will be adapted in online format**

These are pages from the textbook that the students are assigned to read outside of class, so no adaptation is needed.

---

**Assignment Type**

Writing

**In-class and/or outside of class**

In-class
Outside of class

**Formative or Summative**

Summative

**Assignment**

With the data from the in-class experiment where you measured the angles of reflection and refraction, you will write a lab report where you determine if the data you compiled supports the hypothesis that the laws of reflection and refraction are valid.

Your report should include the following content:
Page title with the names of all the group members that worked on the experiment and lab report.
Abstract that contains a summarized what, how, and results from the lab.
Purpose and theory that explains the experiment and the needed equations.
Procedure and apparatus that describes the steps, equipment and set-up used.
Collected data and graphs that shows all the data from the lab in either table or graph form.
Calculations and error analysis that shows how the final result was calculated with its corresponding error bar.
Results and conclusions that states what was learned and how to improve the results.

**How assignment will be adapted in online format**

The laboratory experiments are completed in class during the face to face portion of the course, and the students often begin working on their lab reports when they finish collecting data. The students coordinate to complete their lab reports outside of class. Therefore, no adaptation is needed.

---

**Assignment Type**

Writing

**In-class and/or outside of class**

Outside of class

**Formative or Summative**

Summative

**Assignment**

In this discussion, you will consider and elaborate on the struggles faced by women in physics by answering the following questions: What are some of the differences you have observed between the experience of women in physics versus men in physics. How can the treatment of such powerhouses in mathematics and physics such as Lise Meitner, Émilie du Châtelet, Emmy Noether and Marie Curie affect the interest and confidence of young women seeking careers in physics? Do you think the historical experiences of women in physics over the last hundred years have an impact on the mindset of women entering the field today?

**How assignment will be adapted in online format**

This is a discussion assignment in the CMS. To get credit, students respond to these questions by posting a reply to a discussion in the CMS, so no adaptation is needed.

---

## Course Materials

**Textbooks**

Ling, S. J., Sanny, J., Moebs, B (2025). University Physics Vol.3 OpenStax. ISBN-13: 978-1-947172-22-7

**Other Resources**

Pasco Scientific. Physics Labs with Computers. PASCO Scientific , 01-01-1999.

## Class Size Information

**Class Size**

32

**Class Size Category**

G - Large lab 32

## Diversity and Inclusion

Course Design and Materials: Course will incorporate diverse perspectives, authors, and examples that reflect a variety of cultures, identities, and lived experiences. Instructional materials will be reviewed regularly to ensure representation, inclusivity, and alignment with equity-minded practices across disciplines.

Inclusive Learning Environment: Instructors will establish classroom norms and policies that promote respect, civil discourse, and belonging in both online and face-to-face classes. Clear expectations for communication and engagement will support a learning space where all students feel valued and heard.

Accessible Instruction: Course content will be delivered using accessible design. Materials will follow accessibility guidelines within the CMS, including captioned media, readable document formats, and multiple means of engagement to support diverse learning.

Equitable Teaching Practices: Instructors will use transparent and grading criteria, varied assessment methods, and timely feedback to promote fairness and student success. Opportunities for revision, reflection, and multiple demonstrations of learning may be incorporated when appropriate to the discipline.

Culturally Responsive Pedagogies: Instructional strategies will encourage critical thinking about diverse perspectives and systems of power relevant to the course content. Faculty will foster opportunities for students to connect course material to real-world contexts.

Ongoing Reflection and Improvement: Faculty will engage in continuous professional development related to IDEAA principles and reflect on course practices using metacognition to identify opportunities for increased equity, inclusion, and accessibility.

**Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.**

The content references and discusses the contribution that members from underrepresented groups in STEM have made to our knowledge of classical mechanics. Some assignments, such as readings, research papers and discussions will center on how people of color and women have used their knowledge of classical mechanics to make impactful contributions to their communities or society at large. Examples and assigned problems will apply concepts of classical mechanics to every day situations which can reflect the experiences of students from different backgrounds.

**Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.**

The content presented to the students, either through the CMS or in class, will follow Universal Design for Learning (UDL) guidelines. These guidelines ensure that, among other things, the course content provides different ways of engagement that can appeal to students from a variety backgrounds and that content is presented in different formats so that it can be accessed by students with different abilities. The course promotes an equitable learning environment by adopting the use of Open Educational Resources (OER), like an EOR textbook and an open homework platform, so that the course is accessible to students from different socioeconomic backgrounds. The course also includes a variety of formative and summative assessments so that the methods of evaluation provide students with multiple ways to demonstrate the knowledge of classical mechanics.

## Interactions

**Explain how the course will incorporate student-to-student interaction.**

This course will incorporate student-to-student interaction by having students interact with each other during in class discussions, such as comparing their thought process to determine the relationship between two inertial frames moving with respect to one another at relativistic speeds, or how the de Broglie wavelength is related to quantum mechanical properties of matter. Students will also work on groups to solve some of the problems presented as examples during class or review sessions. During laboratory experiments students will work together to set up the experimental device, perform measurements as well as collect and analyze data. Students may use discussion boards in the CMS to coordinate how to work on their laboratory reports and have all of their collected data in a single place.

**Explain how the course will incorporate instructor-to-student interaction.**

This course will incorporate instructor-to-student interaction by having the instructor present the material in lectures. The instructor may also join the discussion boards if questions arise about the requirements for assignments. Weekly announcements can be used to summarize the content seen in class, remind students of due dates and upcoming assignments. The instructor will provide feedback on students' performance through grading rubrics and comments in the CMS. During lab experiments the instructor will interact with students by providing guidance and clarification on how to perform the laboratory experiments.

**Explain how the course will incorporate student-to-content interaction.**

This course will incorporate student-to-content interaction by having the students engage with the course content from the lectures and content provided in different formats, such as video and audio, posted on the CMS. Students will also interact with the course content by working on solving problems, like calculating the length contraction and time dilation, or computing probabilities of quantum states.

**Explain how the course will incorporate student-to-self interaction (metacognitive).**

This course will incorporate student-to-self interaction by providing multiple opportunities for self-reflection on the process that each student follows to solve a particular problem. A student can for example compare the description of light being reflected by a spherical surface using both the graphical method and the object image relation. By working on solving a variety of problems on their own students will also strengthen their critical thinking skills by distinguishing the necessary and redundant variables among all the information provided in a particular word problem.

Key: 2639