# PHY 203: Modern Physics Spring 2025

**Instructor:** Dr. Truong Le (he,him,his)
**Office:** Trexler 175
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**Credits for the course:** 1
**Lectures Time:** MWF 9:40-10:40 am
**Lectures Room:** Trexler Hall, 272

**Class Environment:** I consider this classroom to be a place where we will treat one another with respect, creating an environment that welcomes individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the course so that I may make appropriate changes to my records. **This syllabus will continue to change with students' notice.**

**Office Hours:** MWF (1:00-2:30 pm), and by appointment.

**Course Description:** Special relativity, particle properties of waves, wave properties of particles, Heisenberg uncertainty principle, Bohr theory, elementary quantum theory and its application to the hydrogen atom. We will also survey selected applications of special relativity and quantum mechanics.

**Textbook:** Modern Physics for Scientists & Engineers (2nd edition) by Thornton and Rex (recommended); Modern Physics (5th edition) by Paul A. Tipler (recommended);

**Purpose of the Course:** In this semester we hope to give you the background and execution of 20th century revolutions in physics. We want to further develop your physical intuition, to extend your physics experience more deeply, especially into relativity and quantum mechanics, to enhance your capacity for solving problems both qualitatively and quantitatively, and for you to understand the motivation and process of the development of modern physics. Major topical areas are: relativity, quantum nature of light, matter waves, and quantum mechanics.

**Goals of the Course:** The primary goals of this course are:

- Attain a clear understanding of the main concepts of special relativity and quantum mechanics.
- Appreciate the problems with classical physics that led to the development of these theories.
- Understand the relevance of the two theories to modern science and technology.
- Gain additional experience using computers (mainly Mathematica) to solve physics problems.

**Participation/Attendance/Tutorial:** You will work on a tutorial (worksheet) every class in a group. You will need to show me your tutorial after every class for credit. Complete or incomplete tutorial will receive 10 points or 7 points, respectively. This course expects you to spend at least 12 hours per week in and out of class. You will rotate to a new group after every exam.

**Homework:** You will have 3 to 4 homework problems assigned after each class, based on the material covered in your reading and the lecture. In this class, I expect you to collaborate with your group to work toward a solution. However, I also expect that you will create an original solution to each assigned problem. Substitutions and simplifications should NOT be left to the "reader" (that's me) to figure out. If necessary, words and phrases need to be properly placed so that I can follow your train of thought. You need to submit all assigned problems on-time before the due date to receive full credit. **Late submission: 10% will be deducted if submitted by 3 pm on the due date.**

**Quizzes:** You will take a 15 minute quiz every Friday. The problems are mainly from the graded homework or completed tutorial with some modifications. No makeup, except, excused absence.

**Laboratory:** The PHYS 203 lab component is taught in a separate meeting by a different instructor (Prof. Fatima), and will complement and ground the material being covered in this course.

**Exams:** The exams in this class will be during the lab period. You may only use your tutorials/notes and homework. The days of the exams will be determined by our progress through the material and the homework assignment schedule.

**Score on the Homework, Quiz, and Exam** are determined by the following rubric:

| Score | Description |
|---|---|
| 5 | The solution is correct and the writing is clear. The instructor can easily see that the student fully understands how to solve the problem. |
| 4 | The solution is mostly correct, but there may be some flaws. The writing is reasonably clear. There is evidence that the student understands the key concepts involved in solving the problem, but may not fully grasp all of the details. |
| 3 | The solution is partly correct, but there are significant errors. The writing may be hard to follow in places. There is evidence that the student does not fully understand the key concepts required to solve the problem, or that the student is unable to use those concepts in an appropriate way. |
| 2 or less | The solution is either completely incorrect or incomprehensible. This may indicate that there are serious flaws in all aspects of the solution, or that the writing was so poor that it was impossible to follow. |

**Grading:** Your grade in this class will be determined by a combination of class participation, homework, lab, quizzes, and exams. The separate weightings will be:

**Class Participation/Quizzes/Tutorials:** 15%

**Homework:** 20%

**Laboratory:** 20%

**Three Exams:** 45% (each-weighted equally)

**Final Grade:** Final course grades will be assigned using the following scale:

| | | | |
|---|---|---|---|
| A | 93% or more | C+ | 77-79.9% |
| A- | 90-92.9% | C | 73-76.9% |
| B+ | 87-89.9% | C- | 70-72.9% |
| B | 83-86.9% | D | 60-69.9% |
| B- | 80-82.9% | F | below 60% |

**MCSP Colloquium Series:** This semester a series of talks will be offered which appeal to a broad range of interests related to math, computer science, and physics. Participation in at least two talks is mandatory. Within one week of attending a talk you must submit (via Inquire) a one-page single-spaced paper. This paper should not only include a summary of the main content of the talk, but also a personal contemplation of the experience. This will be part of the participation grade.

**Accessible Education Services (AES):** Located in the Goode-Pasfield Center for Learning and Teaching in Fintel Library. AES provides reasonable accommodations to students with documented disabilities. To register for services, students must self-identify to AES, complete the registration process, and provide current documentation of a disability along with recommendations from the qualified specialist. Please contact Becky Harman, Assistant Director of Academic Services for Accessible Education, at 540-375-2247 or by e-mail at aes@roanoke.edu to schedule an appointment. If you have registered with AES in the past and would like to receive academic accommodations for this semester, please contact Becky Harman at your earliest convenience to schedule an appointment and/or obtain your accommodation letter for the current semester.

**Academic Integrity:** Your learning and integrity are at the core of your RC education. For this reason, you must follow the rules outline in the College AI policies. See https://www.roanoke.edu/inside/a-z_index/academic_affairs/academic_integrity. **If I become aware of a possible violation of these guidelines, I am contractually obligated to report it to the Academic Integrity committee.**

**Preliminary Schedule:** Topics of discussion from my lectures and videos. I will inform you the reading material at the beginning of every class: The reading chapters are based on Thornton and Rex's textbook.

| **Dates** | **Topic** | **Reading** | Lab |
|---|---|---|---|
| W1: Jan 13 | Introduction to the course | - | |
| 15 | Classical physics | 1.1-1.3 | |
| 17 | Atomic theory & unresolved questions | 1.4-1.6 | |
| W2: 20 | The ether and Michelson-Morley | 2.1-2.2 | **Lab 1:** Function Generator/ |
| 22, 24 | Einstein postulates; Lorentz Transformation | 2.3-2.4 | Oscilloscope |
| W3: 27, 29 | time dilation and length contraction | 2.5-2.6 | |
| 31 | Experimental verifications | 2.7 | |
| W4: Feb 3,5 | The twin paradox and spacetime | 2.8-2.9 | **Lab 2:** Speed of |
| 7, W5: 10 | Relativistic mass and collisions | 2.11-2.12 | Light I and II |
| 12,14 | Relativistic momentum & energy | 2.11-2.12 | |
| W6: 17 | Review/catchup | | |
| 19 | Review/catchup | | |
| Feb 20 | **Exam 1** (chapters 1,2) - During Lab | | No Lab (Feb 20) - Exam 1 |
| 21 | The Electron and Its Charge | 3.1-3.2 | |
| W7: 24 | Line spectra | 3.3-3.4 | **Lab 3:** e/m ratio |
| 26,28 | Blackbody radiation | 3.5 | |
| W8: Mar 1-9 | **Spring Break** | | |
| W9: 10 | Atomic Spectral & Balmer-Rydberg Formula | 3.3-3.8 | |
| 12 | Photoelectric effect (4/group) | 4.3-4.4 | **Lab 4:** Photoelectric |
| 14 | Compton effect | 3.8 | Effect |
| W10: 17 | Rutherford scattering | 4.1-4.3 | |
| 19 | The Bohr model | 4.4-4.5 | |
| 21 | De Broglie waves and scattering | 5.1-5.3 | |
| W11: 24 | The Uncertainty Principle | 5.4-5.6 | **Lab 5:** Young's 2 Slits |
| 26,28 | Probability and wavefunctions | 5.7-5.8 | |
| W12: 31 | Review/catchup | | |
| 2 | Review/catchup | | |
| Apr 3 | **Exam 2** (chapters 3,4,5) During Lab | | No Lab (April 3) - Exam 2 |
| 4 | The Schrodinger's Equation | 6.1 | |
| W13: 7 | Expectation values | 6.2 | **Lab 6:** Circuits/Oscillators/ |
| 9, 11 | Infinite square wells | 6.3,6.5 | Oscilloscopes |
| W14: 14 | Finite square wells | 6.3,6.5 | Diffraction, Oil Drop |
| 16 | Barriers and tunneling | 6.7 | Experiments |
| 16 | Alpha decay and scanning microscopes | 6.7 | |
| 18 | Good Friday (no class) | | **Lab 7:** Radioactivity, Electron |
| W15: 21 | Review/catchup (last day of class) | | |
| Apr 24 | **Exam 3** (chapters 5,6) - @ 8:30-11:30 am | | |

I have read and understood this syllabus. Sign, date, and submit this page for 10 points toward your participation grade on your first day of class.

**Student's Name:** **Date:**