Point Loma Nazarene University
Department of Physics and Engineering
PHY 3003/L Modern Physics and Lab (2 + 1 units)

Spring, 2025
Class meetings: RS 365 MW 2:55 - 3:50
Lab meeting: RS 365 T 1:30-4:00
Final Exam: Monday, May 5 1:30-4:00

Instructor: Dr. Paul D. Schmelzenbach
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Office hours (RS 258): MWF 8:30-9:45, T 9:15-1:00, other times available by appointment.

PLNU Mission: To Teach ~ To Shape ~ To Send
Point Loma Nazarene University exists to provide higher education in a vital Christian community where minds are engaged and challenged, character is modeled and formed, and service is an expression of faith. Being of Wesleyan heritage, we strive to be a learning community where grace is foundational, truth is pursued, and holiness is a way of life.

Department Mission
The Physics and Engineering Department at PLNU provides strong programs of study in the fields of Physics and Engineering. Our students are well prepared for graduate studies and careers in scientific and engineering fields. We emphasize a collaborative learning environment which allows students to thrive academically, build personal confidence, and develop interpersonal skills. We provide a Christian environment for students to learn values and judgment, and pursue integration of modern scientific knowledge and Christian faith.

General Education Mission
PLNU provides a foundational course of study in the liberal arts informed by the life, death, and resurrection of Jesus Christ. In keeping with the Wesleyan tradition, the curriculum equips students with a broad range of knowledge and skills within and across disciplines to enrich major study, lifelong learning, and vocational service as Christ-like participants in the world's diverse societies and culture.

Course Description
An introduction to concepts of modern physics including relativity, quantum theory, atomic physics, and high energy physics.

Program and Course Learning Outcomes
After completing this course, students can

1. list the basic postulates of relativity, and be able to describe some of the basic implications of these that go against our usual intuition (and explain how experimental evidence supports these)
2. analyze simple dynamical processes using relativistic dynamics.
3. provide evidence for quantum mechanics and describe its relevance to modern science and technology
4. apply basic quantum mechanical principles to several introductory situations explain the physical meaning of the mathematical formulation
5. articulate the big ideas from each section
6. justify and explain your thinking and approach to a problem or physical situation sketch and interpret relevant diagrams (such as energy level diagrams or sketches of wavefunctions)
7. conduct experiments and analyze and interpret data
8. effectively communicate technical information

Additionally this course supports the Engineering program through supporting and assessment of ABET requirements:

ABET 3: an ability to communicate effectively with a range of audiences
ABET 5: an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
ABET 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

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Required Texts and Materials:

Physics: Modern Physics by Felder and Felder, Calculator

Course Credit Hour Information
In the interest of providing sufficient time to accomplish the stated course learning outcomes, this class meets the PLNU credit hour policy for a 3-unit class delivered over 15 weeks. Specific details about how the class meets the credit hour requirements can be provided upon request.

Assessment and Grading: The grade you earn in this course is based on the scale below. The points you receive during the course are weighted accordingly:

A	B	C	D	F
92–100 (A)	**87–89** (B+)	**77–79** (C+)	**67–69** (D+)	< 59
90–91 (A–)	**83–86** (B)	**73–76** (C)	**63–66** (D)	
	80–82 (B–)	**70–72** (C–)	**60–62** (D–)	

(2%) Preclass: In preparation for each class meeting, there is a reading assignment. Class meetings are not a standard lecture format, making these reading assignments especially important. Each class day there will a few questions to answer electronically. These will typically be due by 10 pm the evening before class. Your responses to the preclass questions are graded on the following scale: 3=demonstrates reading/thinking; 2=room for improvement, 1=looks pretty last second, 0=unsatisfactory.

(30%) Lab and Activities: provides you the opportunity for a hands-on experience of topics from class and important experiments in modern physics. You will be developing lab techniques, furthering your understanding and operation of lab equipment, applying data analysis techniques, and learning to better communicate findings. Labs will be performed in small groups

(18%) Homework: Problems will be given throughout the course. As with upper-division physics courses, homework is essential to your learning of the material. Problems in this course are usually analytic but will be complemented by computational methods. Problems should be worked neatly in clear logical steps. Solutions should be clear enough one of your peers could easily follow what you did if they had not worked the problem before.

(30%) Exams (3): Three exams will be given during the semester.. Exams will include both multiple-choice or short answer conceptual questions, and problems to solve. Exams will be closed book, but a sheet of formulas will be provided. Partial credit will be given for correct reasoning at any step of a problem, but only if it is communicated clearly enough for me to understand.

(20%) Final exam: The final examination will be comprehensive with an emphasis on the final material in the course and in lab

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Exams: Examinations, including the final examination, will cover topics explored in the text, lecture and through homework. The specific learning outcomes distributed for each section will serve as a valuable study guide.

Late Assignments and Exam Policy: Preclass assignments cannot earn points if submitted late. Homework problems or lab write-ups not submitted on time will receive a 10% deduction per day. After 5 days, an assignment will no longer be accepted for evaluation.

No examination may be missed without prior consent or a well-documented emergency beyond your control. A score of zero will be assigned for any examination missed without prior consent or a documented emergency. If such an event arises, please ensure that you communicate with the professor as soon as possible so other arrangements can be made.

Final Exam
Successful completion of this class requires taking the final examination on its scheduled day. The final examination schedule is posted on the Class Schedules site. If you find yourself scheduled for three (3) or more final examinations on the same day, you are authorized to contact each professor to arrange a different time for one of those exams. However, unless you have three (3) or more exams on the same day, no requests for alternative final examinations will be granted.

Incomplete grade
Incompletes will only be assigned in extremely unusual circumstances. If you believe that your particular circumstances qualify be in clear communication with the professor as soon as you are able.

Course AI policy
Emerging technologies, such as large language models (e.g., ChatGPT), are intriguing and potentially beneficial. However, their pedagogical impact on physics learning outcomes remains somewhat untested. Any work that employs AI-based tools must be clearly identified, including the specific tool(s) used and relevant details. This policy will be further elucidated with examples during lectures. Please be aware that AI policies may differ among classes this semester.

PLNU Academic Accommodations Policy
PLNU is committed to providing equal opportunity for participation in all its programs, services, and activities in accordance with the Americans with Disabilities Act (ADA). Students with disabilities may request course-related accommodations by contacting the Educational Access Center (EAC), located in the Bond Academic Center (EAC@pointloma.edu or 619-849-2486). Once a student's eligibility for an accommodation has been determined, the EAC will work with the student to create an Accommodation Plan (AP) that outlines allowed accommodations. The EAC makes accommodations available to professors at the student's request.

PLNU highly recommends that students speak with their professors during the first two weeks of each semester/term about the implementation of their AP in that particular course. Accommodations are not retroactive so clarifying with the professor at the outset is one of the best ways to promote positive academic outcomes.

Students who need accommodations for a disability should contact the EAC as early as possible (i.e., ideally before the beginning of the semester) to assure appropriate accommodations can be provided. It is the student's responsibility to make the first contact with the EAC. Students cannot assume that because they had accommodations in the past, their eligibility at PLNU is automatic. All determinations at PLNU must go through the EAC process. This is to protect the privacy of students with disabilities who may not want to disclose this information and are not asking for any special accommodations.

Additional Course Information:

Additional PLNU policies and practices that apply to this course can be found at this link

Topics and Assignments at a glance:

Date	Topic	Reading	Hmk
M 1/13	Introductions		
T 1/14	Galilean Relativity; Computation	1.1	
W 1/15	Einstein's Postulates and Time Dilation	1.2	Hmk 1
T 1/21	Uncertainty and Error Propagation		
W 1/22	Length Contraction	1.3	Hmk 2
M 1/27	The Lorentz Transform; Velocity	1.4, 1.5	
T 1/28	Transforms, Expansions, and Space-Time Diagrams	2.1	
W 1/29	Momentum, Energy, and Mass	2.2, 2.3	
M 2/03	Wrap-up and Review		Hmk 3
T 2/04	Michelson Morley (2.5)		
W 2/05	Exam 1: Relativity and Lab Techniques		
M 2/10	Young Double Slit and the photon	3.1-3.3	
T 2/11	Blackbody radiation	3.4	
W 2/12	Photons	3.5-3.6	Hmk 4
M 2/17	Atomic Spectra and Bohr	4.1	
T 2/18	Bohr Model, H atom		
W 2/19	Matter Waves	4.2	Hmk 5
M 2/24	Wavefunctions and Position Probabilities	4.3	
T 2/25	Wavefunctions; LED measurement of h		
W 2/26	Heisenberg Uncertainty Principle	4.4	
M 3/03	Wrap-up and Review		Hmk 6
T 3/04	Exam 2		
W 3/05	Force and PE, Eigenstates	5.1-5.2	
M 3/17	Schrodinger Equation, Infinite Square Well	5.3	
T 3/18	Lab Rotation 1		
W 3/19	Other Bound States	5.4	Hmk 7
M 3/24	Other Bound States, complex numbers	5.4, 5.5	
T 3/25	Lab Rotation 1		
W 3/26	Time Evolution of a Wavefunction	5.6	Hmk 8
M 3/31	Math of Waves, Fourier Transform	6.1-6.2	
T 4/01	Lab Rotation 1		
W 4/02	Momentum Eigenstates	6.3	Hmk 9
M 4/07	Phase and Group Velocity	6.4	
T 4/08	Lab Rotation 2		

Date	Topic	Reading	Hmk
W 4/09	Scattering and Tunneling	6.5	Hmk 10
M 4/14	Exam 3		
T 4/15	Lab Rotation 2		
W 4/16	Application of Modern Physics	TBA	
T 4/22	Lab Rotation 2		
W 4/23	Application of Modern Physics	TBA	Hmk 11
M 4/28	Application of Modern Physics	TBA	
T 4/29	Application of Modern Physics	TBA	
W 4/30	Application of Modern Physics	TBA	Hmk 12
M 5/05	Monday 1:30-4:00 pm		