Point Loma Nazarene University

Department of Physics and Engineering

PHY 3003/L Modern Physics and Lab (2 + 1 units)

Class Meetings: - RS 365 MW 1:30 PM - 2:25 PM, RS 265 R 1:30 PM - 4:20 PM

Instructor: Dr. Paul D. Schmelzenbach
Phone: (619) 849-2933
Email: paulschmelzenbach@pointloma.edu
Office Hours: TBA, Rohr Science 258

Final Exam: Friday, May 8 at 1:30 PM

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.

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

Required Texts and Materials

Modern Physics, 4th edition by Krane.

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 2-unit + 1-unit lab 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:

- **(2%) Preclass:** In preparation for each class meeting, there is a reading assignment. To complete the reading assignment, you must answer 2-3 short questions and submit them electronically by 9 am before class. Late submissions will not earn points.
- **(25%) Lab:** 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. A key piece of this course is developing our skills in communication.
- **(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:** 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.
- **(25%) Final exam:** The final examination will be comprehensive with an emphasis on the final material in the course and in lab.

Grading Scale

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–)	

Late Assignments

Preclass assignments earn half points if submitted late but still before the start of class, after this they receive no credit. Lab assignments and homework problems not submitted on time will receive a late penalty if submitted before the next homework set, otherwise they will not receive any points.

Exams and Missing Exam Policy

Examinations and the Final Examination will include problems and questions over material assigned in the text, explored in homework, as well as material presented in class. Distributed specific learning outcomes for the section, or for the entire class will provide a good means of study. A score of zero will be assigned for an examination that is missed without prior consent or a well-documented emergency beyond your control. 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 Assignment

A grade of incomplete 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.

Artificial Intelligence (AI) Policy

You are allowed to use Large Language Models (like ChatGPT, NotebookLM, Claude, etc.) as a study tool, but not on any exams. Work that utilizes AI-based tools should be identified as such including the tool used. Specific use cases will be clarified in class.

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 619-849-2533). 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. Professors are able to view a student's approved accommodations through Accommodate.

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 accommodations.

Additional Course Information

Additional PLNU policies and practices that apply to this course can be found here https://docs.google.com/document/d/11BgAANLOJ9tjt837d24EZ181ukM2qzHF/edit .

LomaBooks Instructions for Students

This course is part of our course material delivery program, LomaBooks. The bookstore will provide each student with a convenient package containing all required physical materials; all digitally delivered materials will be integrated into Canvas.

You should have received an email from the bookstore confirming the list of materials that will be provided for each of your courses and asking you to select how you would like to receive any printed components (in-store pick up or home delivery). If you have not done so already, please confirm your fulfillment preference so the bookstore can prepare your materials.

For more information about LomaBooks, please go here.

Class Meeting Planned Calendar

Date	Topic	Reading	Homework	Lab (Thursdays)
1/12	Introductions & Classical Physics	1.1		Uncertainty

1/14	Classical Relativity & the Ether Problem	2.1-2.2	Hmk01	
1/15	Einstein's Revolution	2.3-2.4		
1/21	Lorentz Transformations	2.4-2.5	Hmk02	Michelson-Morley I
1/22	Paradoxes and Spacetime	2.6		
1/26	Relativistic Dynamics I	2.7		Michelson-Morley II
1/28	Relativistic Dynamics II	2.8	Hmk03	
1/29	Waves & Interference	3.1		
2/02	The Photoelectric Effect	3.2		LED I
2/04	Thermal Radiation	3.3	Hmk04	
2/05	Compton Effect and other photon interactions	3.4-3.5		
2/09	Wrap up	3.6		LED II
2/11	Exam 1		Hmk05	
2/12	de Broglie waves	4.1-4.2		
2/16	Uncertainty Relations	4.3-4.4		Rotation 1
2/18	Wave Packets	4.5-4.6	Hmk06	
2/19	Full Lab Day			
2/23	The Schrodinger Equation I	5.1-5.2		Rotation 1
2/25	The Schrodinger Equation II	5.3-5.4	Hmk07	
2/26	Applications of SE	5.4		
3/02	SHO and Steps and Barriers I	5.5-5.6		Rotation 2
3/04	SHO and Steps and Barriers II	5.5-5.6	Hmk08	
3/05	Full Lab Day			
3/16	Wrap up			Rotation 2
3/18	Exam 2		Hmk09	
3/19	Basic Atoms	6.1-6.3		
3/23	Line Spectra and Bohr	6.4-6.5		Rotation 3
3/25	Frank-Hertz; Bohr	6.6-6.8	Hmk10	

3/26	Full Lab Day			
3/30	Hydrogen Atom I	7.1-7.3		No Lab
4/01	Hydrogen Atom II	7.4-7.5	Hmk11	
4/08	Hydrogen Atom III	7.6		Rotation 3
4/09	More Spin	7.6-7.7		
4/13	Many Electron Atoms I	8.1-8.3		Rotation 4
4/15	Many Electron Atoms II	8.4-8.5	Hmk12	
4/16	Full Lab Day			
4/20	Lasers	8.6-8.7		Rotation 4
4/22	Wrap up		Hmk13	
4/23	Exam 3			
4/27	Nuclear 1	12.1-12.4		Wrap-up
4/29	Nuclear 2	12.5-12.7		
4/30	Nuclear 3	12.8-12.10	Hmk 14	
5/07	Final F 1:30-4:00			