

Point Loma Nazarene University
Department of Physics and Engineering
PHY3004: Modern Physics and Lab (3 + 1 units)

Spring Semester, 2024

Class meetings MWF: 1:30-2:20 (RS 365)

Lab meetings (RS 125) R: 1:30-4:20

Final Exam: Mon, April 29: 1:30 - 4:00 pm

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Office hours: MWF 12-1; T 9-10, R 9-11:30. 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.

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
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Required Texts and Materials

Physics: Modern Physics by Felder and Felder

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 4-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:

(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 be 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.

(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 pairs.

(23%) 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.

A	B	C	D	F
A 92-100	B+ 87-89	C+ 77-79	D+ 67-69	F Less than 59
A- 90-91	B 83-86	C 73-76	D 63-66	
	B- 80-82	C- 70-72	D- 60-62	

Exams

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.

Late Assignments and Exam Policy: No examination shall be missed without prior consent or a well-documented emergency beyond your control. A score of zero will be assigned for an examination that is missed without prior consent or a well-documented emergency beyond your control. 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 shall be missed without prior consent or a well-documented emergency beyond your control. A score of zero will be assigned for an examination that is missed without prior consent or a well-documented emergency beyond your control.

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.

State Authorization

State authorization is a formal determination by a state that Point Loma Nazarene University is approved to conduct activities regulated by that state. In certain states outside California, Point Loma Nazarene University is not authorized to enroll online (distance education) students. If a student moves to another state after admission to the program and/or enrollment in an online course, continuation within the program and/or course will depend on whether Point Loma Nazarene University is authorized to offer distance education courses in that state. It is the student's responsibility to notify the institution of any change in his or her physical location. Refer to the map on [State Authorization](#) to view which states allow online (distance education) outside of California.

PLNU Copyright Policy

Point Loma Nazarene University, as a non-profit educational institution, is entitled by law to use materials protected by the US Copyright Act for classroom education. Any use of those materials outside the class may violate the law.

PLNU Academic Honesty Policy

Students should demonstrate academic honesty by doing original work and by giving appropriate credit to the ideas of others. Academic dishonesty is the act of presenting information, ideas, and/or concepts as one's own when in reality they are the results of another person's creativity and effort. A faculty member who believes a situation involving academic dishonesty has been detected may assign a failing grade for that assignment or examination, or, depending on the seriousness of the offense, for the course. Faculty should follow and students may appeal using the procedure in the university Catalog. See [Academic Policies](#). for definitions of kinds of academic dishonesty and for further policy information.

PLNU Academic Accommodations Policy

PLNU is committed to providing equal opportunity for participation in all its programs, services, and activities. 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 issue an academic accommodation plan ("AP") to all faculty who teach courses in which the student is enrolled each semester.

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 and/or if they do not wish to utilize some or all of the elements of their AP in that course.

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.

PLNU Attendance and Participation Policy

Regular and punctual attendance at all class sessions is considered essential to optimum academic achievement. If the student is absent for more than 10 percent of class sessions, the faculty member will issue a written warning of de-enrollment. If the absences exceed 20 percent, the student may be de-enrolled without notice until the university drop date or, after that date, receive an “F” grade.

Class Enrollment:

It is the student’s responsibility to maintain his/her class schedule. Should the need arise to drop this course (personal emergencies, poor performance, etc.), the student has the responsibility to follow through (provided the drop date meets the stated calendar deadline established by the university), not the instructor. Simply ceasing to attend this course or failing to follow through to arrange for a change of registration (drop/add) may easily result in a grade of F on the official transcript.

Sexual Misconduct and Discrimination

In support of a safe learning environment, if you (or someone you know) have experienced any form of sexual discrimination or misconduct, including sexual assault, dating or domestic violence, or stalking, know that accommodations and resources are available through the Title IX Office at pointloma.edu/Title-IX. Please be aware that under Title IX of the Education Amendments of 1972, faculty and staff are required to disclose information about such misconduct to the Title IX Office.

If you wish to speak to a confidential employee who does not have this reporting responsibility, you can contact Counseling Services at counselingservices@pointloma.edu or find a list of campus pastors at pointloma.edu/title-ix.

Spiritual Care

Please be aware PLNU strives to be a place where you grow as whole persons. To this end, we provide resources for our students to encounter God and grow in their Christian faith. If students have questions, a desire to meet with the chaplain or have prayer requests you can contact the [Office of Spiritual Development Links to an external site.](#)

Topics at a glance:

1/8	Introductions	
1/10	Galilean Relativity	1.1
1/12	Einstein's Postulates and Time Dilation	1.2
1/17	Length Contraction and Simultaneity	1.3
1/19	The Lorentz Transforms	1.4
1/22	Velocity Transforms and the Doppler Effect	1.5
1/24	Spacetime Diagrams	2.1
1/26	Momentum and Energy	2.2
1/29	Mass and Energy	2.3
1/31	Exam 1	
2/2	The Young Double-Slit Experiment	3.1-3.2

2/5	One Photon at a Time	3.3
2/7	Blackbody Radiation	3.4
2/9	Photoelectric Effect; Photons	3.5-3.6
2/12	Atomic Spectra and Bohr	4.1
2/14	Matter Waves	4.2
2/16	Wavefunctions and Position Probabilities	4.3
2/19	Heisenberg Uncertainty Principle	4.4
2/21	Force and Potential Energy	5.1
2/23	Exam 2	
2/26	Energy Eigenstates	5.2
2/28	The Infinite Square Well	5.3
3/1	Other Bound States	5.4
3/11	Complex Numbers	5.5
3/13	Time Evolution of a Wavefunction	5.6
3/15	Math of Waves	6.1
3/18	Free Particles and Fourier Transforms	6.2
3/20	Momentum Eigenstates	6.3
3/22	Phase and Group Velocity	6.4
3/25	Scattering and tunneling	6.5
3/27	Exam 3	
4/3	Quantum numbers of the Hydrogen Atom	7.1
4/5	Spin	7.5
4/8	Spin and Measurement	7.6
4/10	Splitting of Spectra Lines	7.7
4/12	Pauli Exclusion Principle	8.1
4/15	Energy Levels and Atomic States	8.2-8.3
4/17	What's in a Nucleus	12.1
4/19	Experimental Nuclear Properties	12.2
4/22	Nuclear Models	12.3
4/24	Nuclear Decay	12.4
4/26	Nuclear Fission and Fusion	12.5