Point Loma Nazarene University

Department of Physics and Engineering

PHY3004/L: Modern Physics and Lab (3 + 1 units)

MWF: 12:15-1:10 (RS 365); Lab R 12:30 PM - 2:15 PM (RS 125)

Spring 2023: January 10 - April 28

Instructor: Dr. Paul D. Schmelzenbach

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Office hours: TR 9-10; MWF 8:30-10:00 (RS258); or Appointment as needed (also via zoom)

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
5. articulate the big ideas from each section
6. justify and explain your thinking and approach to a problem or physical situation
7. sketch and interpret relevant diagrams (such as energy level diagrams or sketches of wavefunctions)
8. conduct experiments and analyze and interpret data
9. effectively communicate technical information

Required texts and Recommended Study Resources: Modern Physics, 4th Edition by Krane; Access to MATLAB (or Python can be used)

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:

- 3% Preclass - Each class day there will a few questions to answer electronically. These will typically be due by 10 am the before class. Your responses to the preclass questions are graded on the following scale: 2=demonstrates reading/thinking; 1=room for improvement, 0=unsatisfactory.
- 22% 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.
- 20% 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.
- 35% 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 to you to use during your exam. 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. For problems that call for a solution or explanation, no credit will be given for an answer alone; the method or reasoning must also be shown.

- 20% Final exam - The final exam is Friday May 5 at 10:30 am. The final examination will be comprehensive with an emphasis on the final material in the course.

Final Grades will be based on the following:

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	

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.

Late preclass assignments do not earn points. Homework and Labs submitted late receive a 20% deduction per day unless other arrangements have been made ahead of time with the instructor.

Spiritual Care: PLNU strives to be a place where students grow as whole persons. To this end, we provide resources for our students to encounter God and grow in their Christian faith.

If you have questions, a desire to meet with the chaplain, or if you have prayer requests, you can contact the Office of Student Life and Formation.

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.

Final Exam: The final exam date and time is set by the university at the beginning of the semester and may not be changed by the instructor. This schedule can be found on the university website and in the course calendar. No requests for early examinations will be

approved. Only in the case that a student is required to take three exams during the same day of finals week, is an instructor authorized to consider changing the exam date and time for that particular student.

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.

Incompletes: Incompletes will only be assigned in extremely unusual circumstances.

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.

Sexual Misconduct and Discrimination: Point Loma Nazarene University faculty are committed to helping create a safe learning environment for all students. 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 help and support 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, it is 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

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 the appropriate grade for their work and participation.

1/10	Introductions and Review	1.1
1/11	Deficiencies in Classical Physics I	1.2-1.3
1/13	Deficiencies in Classical Physics II	1.3-1.4
1/18	Special Relativity I	2.1-2.3
1/20	Special Relativity II	2.4
1/23	Special Relativity III	2.5-2.6
1/25	Special Relativity IV	2.7
1/27	Special Relativity V	2.7-2.8
1/30	EM waves and the photoelectric effect	3.1-3.2
2/1	Thermal Radiation	3.3
2/3	Compton Effect, Pair Production	3.4-3.6
2/6	Exam 1: Chapters 1-3	
2/8	de Broglie waves	4.1-4.2
2/10	Uncertainty Principle	4.3-4.4
2/13	Wave Packets	4.5-4.6
2/15	Wave Packets and Probability	4.6-4.7
2/17	Waves at Boundaries	5.1-5.2
2/20	The SE I	5.3-5.4
2/22	The SE II	5.3-5.4
2/24	SHO	5.5
2/27	Steps and Barriers	5.6
3/1	Atoms	6.1-6.3
3/3	Line Spectra	6.4-6.5

1/10	Introductions and Review	1.1
3/13	Atoms Wrap	6.6-6.8
3/15	Exam 2: Chapters 4-6	
3/17	1D and angular Momentum	7.1-7.2
3/20	Hydrogen Wavefunctions	7.3-7.5
3/22	Intrinsic Spin	7.6
3/24	Spectroscopy	7.7-7.9
3/27	Many Electron	8.1-8.2
3/29	Many Electrons II	8.3-8.4
3/31	X-rays and Lasers	8.5; 8.7
4/3	Bonding	9.1-9.3
4/5	Vibrations, Rotations, and Spectra	9.4-9.6
4/12	Wrap up	
4/14	Exam 3: Chapter 7-9	
4/17	Nuclear 1	12.1-12.4
4/19	Nuclear 2	12.5-12.7
4/21	Nuclear 3	12.8-12.10
4/24	Highlights of Fission and Fusion	(13.4-13.5)
4/26	Elementary Particles I	14.1-14.4
4/28	Elementary Particles II	14.5-14.8
5/5	Final Exam: Friday at 10:30 am	