Point Loma Nazarene University
Department of Physics and Engineering
EGR3013/L - Nuclear Physics (2 unit + 1 unit)
MWF 7:25-8:20; R 7:25 - 9:10 Rohr Science 265
Fall 2022: August 30 - December 9

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Office hours: MTWRF 6:15-7:20 (RS258) / 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
A survey of nuclear physics including nuclear models, laws of radioactive decay, radiation detection, and applications of nuclear science in engineering and medicine. Lecture and laboratory.

Course Learning Outcomes

1. Students will be aware of and demonstrate ALARA
2. Students will be able to collect and analyze data of basic experiments in nuclear physics
3. Students will be able to sketch and explain features of common plots and graphical

representations used in nuclear physics
4. Students will be able to understand the basic theory of alpha, beta, and gamma radiation and how each type of radiation interacts with matter
5. Students will be able to describe the essential features of the operation of a nuclear reactor and the interaction between the various important parameters
6. Students will be able to explain the physical meaning of mathematical formulations
7. Students will be able to justify and explain their thinking and approach to a problem or physical situation in written or oral form.
8. Students will be able to sketch the physical parameters of a system and their relations to each other appropriately.
9. Students will be able to use appropriate databases and computational tools to solve problems in nuclear physics.
10. Students will demonstrate proficiency of use and technique of typical equipment used in the nuclear physics setting

Program Learning outcomes

This course contributes to meeting the program outcomes by developing student skills in the following areas. Students will have

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (LO1)
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. (LO2)
3. An ability to communicate effectively with a range of audiences. (LO3)
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. (LO4)
5. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies. (LO7)

Required texts and Recommended Study Resources

1. Lilley, John. Nuclear physics: principles and applications. John Wiley & Sons, 2013.
2. We will be using several online resources and downloadable software packages through the semester including python (or MATLAB) and LaTeX.
3. online resources including the chart of nuclides, or nudat, the national nuclear data center has many links, as does NIST including: estar, pstar, and astar.

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:

- (25%) Lab provides you the opportunity for a hands-on experience of topics from class meetings, developing lab technique, understanding of basic equipment from the nuclear lab, and data analysis. Labs will be performed in small groups, but each individual is responsible for submitting their own documents unless otherwise specified. Depending on covid regulations at the time of the meetings, there may be more emphasis placed on data analysis.
- (20%) Homework is exceedingly important for developing an understanding of the course material, not to mention building skills in complex physical and mathematical problem solving. Remember that it is not just a "correct solution" that is the goal, it is the process to the solution that will develop your skill as a physicist or engineer. I encourage you to work together on the homework sets, but you must participate in the process of obtaining the solution to each problem. The guideline is that you should have no trouble explaining or repeating work that you turn in.
- (5%) Preclass - 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: 2=demonstrates reading/thinking; 1= significant room for improvement, 0=unsatisfactory or not submitted by class-time.
- (30%) In-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

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	

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.

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.

Homework and Lab assignments that are submitted late without prior consent will have an automatic deduction of 20 percent per day late. Preclass assignments submitted late will not earn points.

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.

Incomplete Grade Assignment

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.

Course Calendar

Date	Topic	Reading	Hmk
8/30	Introductions		
8/31	Nuclear Basics; QM review	1.1-1.4.1	
9/02	Energy Levels	1.4.1-1.4.2	Hmk 1
9/07	Overview of Decay	1.4.3-1.5.4	
9/09	Radioactive Decay; Geiger Counters	1.5.5-1.5.7	Hmk 2
9/12	Wrap up Decay Chains; Cross Sections	1.6-1.6.3	
9/14	Nuclear Reactions	1.6.4-1.6.5	
9/16	SEMF	2.1-2.2	Hmk 3
9/19	The Shell Model	2.3-2.4	
9/21	The Shell Model; Single Particle	2.3-2.4	
9/23	Collective States	2.5	

9/26	Wrap-up and Catchup		Hmk 4
9/28	Exam I		
9/30	Gamma Decay I	3.1-3.2	
10/03	Gamma Decay II	3.1-3.2	
10/05	Beta Decay I	3.3	
10/07	Beta Decay II	3.3	Hmk 5
10/10	Alpha Decay I	3.4	
10/12	Alpha Decay II	3.4	
10/14	Heavy Charged Particles and Matter	5.1-5.2	Hmk 6
10/17	Heavy Charged Particles and Electrons	5.3	
10/19	Gamma Rays I	5.4	Hmk 7
10/24	Gamma Rays II	5.4	
10/26	Neutrons	5.5	
10/28	Wrap-up and Catchup		Hmk 8
10/31	Exam II		
11/02	Detectors: Gas and Scintillation	6.1-6.4	
11/04	Detectors	6.4-6.7	Hmk 9
11/07	Detectors and Accelerators	6.7-6.8	
11/09	Biological Effects 1	7.1-7.3	
11/11	Biological Effects 2	7.4-7.6	Hmk 10
11/14	Applications	8.1-8.3	
11/16	Applications	8.4-8.7	
11/18	Fission 1	10.1-10.3	
11/21	Fission 2	10.3	

11/28	Fission 3	10.5-10.7	
11/30	Review and Catch-up		Hmk 11
12/02	Exam III		
12/05	Fusion I		
12/07	Fusion II		
12/09	Wrap-up		Hmk 12
12/16	Final Exam		