

**PHY 4053 – Quantum Mechanics 3 Units**

**Fall 2019**

**PLNU Mission Statement**

**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.

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**Office Hours:** MWF 12:00-1:00PM, WF 2:45-4:00PM, T 10:00-12:00, or by appointment. NOTE if you really need to see me, I will also be around MF from about 10:00AM to 11:00AM but this is also around Chapel time – so you'll have to make up Chapel one evening.

**Regular meeting times Sep 4, 2019 – December 13, 2019**

**Lecture:** MWF 11:00 AM – 11:55 PM (RS 265)

**Final Exam: Wed Dec 18, 2019, 10:30 AM to 1:00 PM**

**Textbook:** Introduction to Quantum Mechanics 3<sup>rd</sup> Ed., by Griffiths & Schroeter, Cambridge University Press, 2018

**Course Description:** A rigorous introduction to quantum physics including Schrödinger's equation, matrix mechanics, perturbation theory, and applications in atomic and molecular physics.

Prerequisite(s): PHY 304 and MTH 274.

Recommended: MTH 333

**Student Learning Outcomes:** In this course there are a number of specific goals for you to meet from each chapter. These smaller goals fit into the following overall learning outcomes of the physics and engineering programs to: develop an understanding of the fundamental principles of physics and of engineering; apply physical principles, mathematical reasoning, and computational techniques to solve real-world problems; analyze and interpret data; and effectively communicate complicated technical information. Once you complete this course, you should be able to:

1. apply quantum mechanical principles to several situations;
2. explain the physical meaning of the mathematical formulation;
3. articulate the big ideas from each section of each chapter such as the wave function, stationary states, potential energy wells, observables, the uncertainty principle, the three-dimensional Schrödinger equation, the hydrogen atom, systems of identical particles;
4. justify and explain your thinking and approach to a problem or physical situation; and
5. sketch and interpret relevant diagrams (such as energy level diagrams or sketches of wave functions and their probabilities.)

**Preclass Assignments:** Preclasses are assigned for each class day and are due by 11:59PM the night before class. Your responses to the pre-class questions are graded as follows: 2 = demonstrates reading of material and thinking about material; 1 = room for improvement; 0 = unsatisfactory. Preclass comprises 5% of your grade.

**Homework/Classwork:** Problems assigned throughout the course are essential to your learning the material. Problems in this course are largely analytic but may be complemented by computational methods. Problems should be worked neatly in clear logical steps. Solutions should be clear enough that one of your peers could easily follow what you did if they had not worked the problem before. Homework/Classwork comprises 20% of your grade. HW sets are due at the beginning of class and will not be accepted late. Classwork cannot be made up.

**Collaboration:** Scientists and engineers collaborate, and I expect and encourage you to collaborate with your peers while working on homework and labs, **however** your work should be your own. The guideline is that you should have no trouble explaining or repeating the work you turn in. No homework solutions should look identical.

**Late Work:** Late work will not be accepted unless there is a documented emergency. Assignments are due as noted on the syllabus, in class, and on Canvas. Incompletes are only assigned in extremely unusual circumstances.

*You must take ALL the exams and the final in order to pass the class.*

**Exams:** There will be five Exams during the semester, each worth 10% of your grade. Exams make a total of 50% of your grade. You must take all exams to pass the course.

**Final Exam: Wed Dec 18, 2019, 10:30 AM to 1:00 PM** 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.

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. **No requests for early examinations or alternative days will be approved.** The final exam is worth 25% of your grade.

**Missed Exam Policy:** No make-up exams are allowed except for warranted circumstances. Arrangements must be made with me as soon as possible.

**Final Course Grade:** The points you receive during the course are weighted accordingly:

Component	Weight
Pre-Class	5%
Homework/Classwork	20%
Exams	50% (equally weighted)
Final Exam	25%

The grade you earn in this course is based on the following scale:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-
S <sub>≥</sub> 91.5	91.5 >S <sub>≥</sub> 89.5	89.5 >S <sub>≥</sub> 86.5	86.5 >S <sub>≥</sub> 81.5	81.5 >S <sub>≥</sub> 79.5	79.5 >S <sub>≥</sub> 76.5	76.5 >S <sub>≥</sub> 71.5	71.5 >S <sub>≥</sub> 69.5	69.5 >S <sub>≥</sub> 66.5	66.5 >S <sub>≥</sub> 61.5	61.5 >S <sub>≥</sub> 59.5

**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.

**PLNU Attendance and Participation Policy:**

Attendance is expected at each class session. In the event of an absence you are responsible for the material covered in class and the assignments given that day.

Regular and punctual attendance at all classes is considered essential to optimum academic achievement. If the student is absent from more than 10 percent of class meetings, the faculty member can file a written report, which may result in 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. See [http://catalog.pointloma.edu/content.php?catoid=24&navoid=1581#Class\\_Attendance](http://catalog.pointloma.edu/content.php?catoid=24&navoid=1581#Class_Attendance) in the Undergraduate Academic Catalog.

**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.

**Academic Accommodations:**

While all students are expected to meet the minimum standards for completion of this course as established by the instructor, students with disabilities may require academic adjustments, modifications or auxiliary aids/services. At Point Loma Nazarene University (PLNU), these students are requested to register with the Disability Resource Center (DRC), located in the Bond Academic Center. ([DRC@pointloma.edu](mailto:DRC@pointloma.edu) or 619-849-2486). The DRC’s policies and procedures

for assisting such students in the development of an appropriate academic adjustment plan (AP) allows PLNU to comply with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act. Section 504 (a) prohibits discrimination against students with special needs and guarantees all qualified students equal access to and benefits of PLNU programs and activities. After the student files the required documentation, the DRC, in conjunction with the student, will develop an AP to meet that student's specific learning needs. The DRC will thereafter email the student's AP to all faculty who teach courses in which the student is enrolled each semester. The AP must be implemented in all such courses.

If students do not wish to avail themselves of some or all of the elements of their AP in a particular course, it is the responsibility of those students to notify their professor in that course. PLNU highly recommends that DRC students speak with their professors during the first two weeks of each semester about the applicability of their AP in that particular course and/or if they do not desire to take advantage of some or all of the elements of their AP in that course.

**Credit Hour:**

In the interest of providing sufficient time to accomplish the stated course learning outcomes, this class meets the PLNU credit hour policy for any 4 unit class delivered over 15 weeks. Specific details about how the class meets the credit hour requirements can be provided upon request.

**Copyright Protected Materials:**

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 [http://catalog.pointloma.edu/content.php?catoid=24&navoid=1581#Academic\\_Honesty](http://catalog.pointloma.edu/content.php?catoid=24&navoid=1581#Academic_Honesty) for definitions of kinds of academic dishonesty and for further policy information.

**FERPA Policy:** In compliance with federal law, neither PLNU student ID nor social security number should be used in publicly posted grades or returned sets of assignments without student written permission. This class will meet the federal requirements by distributing grades and papers individually. Also, in compliance with FERPA, you will be the only person given information about your progress in this class unless you have designated others to receive it in the "Information Release" section of the student portal. See Policy Statements in the undergrad academic catalog.

**TENTATIVE SCHEDULE – subject to updates**

Pre-class assignments on Canvas are due by 11:59PM the night before class, HW is due at the start of class on the day listed.

<b>Date</b>	<b>Topics and Readings</b>	<b>Assignments</b>
9/4 W	<i>Readings are due before class starts, the first day is an exception.</i>  Read entire preface of Griffith Chapter 1.1-1.4	Pre-classes are due by 11:59PM the before class. The first pre-class is an exception, it is due tonight by 11:59PM  PC1 due 9/4 11:59pm
9/6 F	Chapter 1.5-1.6	PC2 HW1: 1.1, 1.2, 1.3, 1.5 See Canvas for full assignments
9/9 M	Chapter 2.1-2.2	PC3 due HW2: 1.7, 1.9, 1.10. 1.16, 1.18
9/11 W	Chapter 2.1-2.2 Chapter 2.3.1	PC4
9/13 F	Chapter 2.3.1	PC5 HW3: 2.1, 2.2, 2.3, 2.4, 2.5, 2.7
9/16 M	Chapter 2.3.1-2.3.2	PC6 HW4: 2.10, 2.11, 2.12 See Canvas for full assignment
9/18 W	Chapter 2.3.2-2.4	PC7
9/20 F	Chapter 2.4-2.5	PC8 HW5: 2.14
9/23 M	Chapter 2.5-2.6	PC9 HW6: 2.17, 2.20
9/25 W	Chapter 2.6	PC10 HW7: 2.22 (+graph part c), 2.23, 2.26
9/27 F	Catch up/review	PC11 HW8: 2.29, 2.34, 2.48, extra credit 2.53
9/30 M	<b>EXAM 1 Chapters 1-2</b>	PC12 Read the Appendix
10/2 W	Appendix	PC13 HW9: A.8, A.9, A.11, A18, A28
10/4 F	Chapter 3.1-3.2	PC14
10/7 M	Chapter 3.1-3.2	PC15 HW10: 3.2, 3.3, 3.5,
10/9 W	Chapter 3.3	PC16
10/11 F	Chapter 3.4 – 3.5	PC17 HW11: 3.8
10/14 M	Chapter 3.5	PC18 HW12: 3.11, 3.13

<b>Date</b>	<b>Topics and Readings</b>	<b>Assignments</b>
10/16 W	Chapter 3.6	PC19 HW13: 3.14, 3.15, 3.18
10/18 F	Catch up/review	PC20 HW14: 3.23, 3.26, 3.31, 3.36, 3.37 note: not a hw problem, but 3.38 & 3.41 are great practice
<b>10/21 M</b>	<b>EXAM 2 Chapter 3</b>	PC21
10/23 W	Chapter 4.1	PC22
10/25 F	NO CLASSES Fall Break Day	
10/28 M	Chapter 4.1 – 4.2	PC23 HW15: 4.1, 4.2, 4.3, 4.4, 4.7
10/30 W	Chapter 4.2	PC24
11/1 F	Chapter 4.2 – 4.3	PC25 HW16: 4.12, 4.13
11/4 M	Chapter 4.3	PC26 HW17: 4.14, 4.15, 4.19
11/6 W	Chapter 4.3-4.4	PC27
11/8 F	Chapter 4.4	PC 28 HW18: 4.21, 4.22, 4.24, 4.25
11/11 M	Chapter 4.5	PC29 HW 19: 4.30, 4.31, 4.32, 4.35
11/13 W	Catch up/review	PC30 HW20: 4.37, 4.39, 4.46
<b>11/15 F</b>	<b>Exam 3 Chapter 4</b>	PC 31
11/18 M	Chapter 5.1	PC32
11/20 W	Chapter 5.2, 5.3	PC33 HW 21: 5.4, 5.6, 5.7, 5.9
11/22 F	Chapter 5.3	PC34 HW22: 5.15, 5.17, 5.18
11/25 M	Chapter 12 Take Home Exam 5 given	PC35 HW23: 5.20, 5.24, 5.25 (see canvas)
11/27-29 W Th F	NO CLASSES Thanksgiving Break	Read 6.1-6.8
12/2 M	<b>Exam 4 Chapters 5, 12</b>	PC36
12/4 W	Chapter 6.1-6.4	PC37

<b>Date</b>	<b>Topics and Readings</b>	<b>Assignments</b>
12/6 F	Chapter 6.5-6.8, 7.1-7.4	PC38 HW24: 6.1, 6.2, 6.8, 6.13
12/9 M	Chapter 7.1-7.4, 8.1	PC39 HW25: 6.21, 6.29
<b>12/11 W</b>	Chapter 8.1, 9.1-9.2	PC40 HW26: 7.2, 7.5 7.25
12/13 F	REVIEW for Final	PC41 <b>Take Home Exam 5 due</b>
<b>12/18 W</b>	<b>Wed Dec 18, 2019, 10:30 AM to 1:00 PM</b>	
	Grades turned in by Dec29	