LUMS
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Lahore University of Management Sciences

PHY 312 – Quantum Mechanics II

Spring 2024

To understand how to navigate course outlines, consult: How to Use a Course Outline (http://surl.li/gpvuw)

Instructor	Rizwan Khalid
Room No.	9-113A
Office Hours	TBA. On most days, an email appointment will be appreciated.
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Telephone	042-3560-8361
Secretary/TA	TBD
TA Office Hours	N/A
Course URL	On LMS
Support Services	LUMS offers a range of academic and other services to support students. These are mentioned below, and you are encouraged to use these in addition to in-class assistance from course staff. For a complete list of campus support services available for you click here (https://advising.lums.edu.pk/#supportservices)

Course Basics				
Credit Hours	3			
Lecture(s)	Nbr of Lec(s) Per Week	2	Duration	75 mins
Tutorials(s)	Nbr of Lec(s) Per Week	1	Duration	75 mins

Course Distribution	
Core	
Elective	Intended for Physics Majors and graduate students in Physics.
Open for Student Category	All
Close for Student Category	

Course Distribution	
Core	Physics majors
Elective	
Open for Student Category	All
Closed for Student Category	

Course Description
This course builds on the narrative built in PHY 212 (Quantum Mechanics I) and is a natural sequel. The emphasis is twofold: (a) solving Schrodinger equation for systems enabling exact solutions and (b) using basic approximation techniques in quantum mechanics. Throughout the course, we will explore pertinent examples.

Course Prerequisites
PHY 212: Quantum Mechanics I. Also needed is a lot of hard work.

Learning Outcomes (CLOs)		Cognitive Level
1	Analyze angular momentum and apply it to compute the hydrogen atom quantum states	Analysis
2	Analyze various physical phenomena using perturbation theory	Analysis
3	Demonstrate an understanding of assorted advanced topics (symmetries including the Heisenberg picture, symmetry, and entanglement)	Analysis
4	Demonstrate effective writing and speaking skills via course project and presentation	Analysis

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Grading break up: Component Details and weightages
Assignments (15%): 5-7. Assignments shall normally be due no less than a week after they are handed out. An N-2 shall be implemented. **Quizzes (10%): Most weeks.** A short (5-10 min) recall quiz will be held most weeks. Please ensure you reach the lecture room before the beginning of the class. If you have attended the lectures diligently you will find the quizzes to be trivial. An N-3 shall be implemented. **Mid-Term Exam (25%):** A 75-minute mid-term shall be scheduled in week 9 (or as per departmental policy). **Project: (30%)**. A comprehensive project will take care of a large chunk of your course grade. The project report will be due towards the end of week 13 of the semester. We shall have presentations in week 14. This 30% is further broken down into the following components (detailed instructions will be given later): • Project Report (12%): The largest chunk goes to the project report which must be typeset in my favorite style which is that of the Journal of High Energy Physics (JHEP). • Presentation (6%): The actual presentation will be worth 6% of credit. Each member of the team will speak for ten or so minutes and grading is individual. • Asking Questions (4%): The quality of the questions you ask says a lot about your absorption of the material. 4% of your grade will depend on the questions you ask. • Answering Questions (8%): Finally, 8% of your grade will depend on questions that will be directed to you individually. **Final Exam (30%):** A four-hour comprehensive final exam on date decided by the RO.
Grading Basis (Relative)
As per departmental policy.

Examination Detail	
Midterm Exam	**Yes** Combined/Separate: N/A Duration: 75 mins Preferred Date: Week 9 (as decided by the department) Exam Specifications: Based on material covered till the week before the exam.
Final Exam	**Yes** Combine/Separate: N/A Duration: 4 hours Exam Specifications: Comprehensive final exam on date decided by the RO. Since the RO schedules only 3-hour slots, expect this to be the last exam on the day.

Campus supports & Key university policies

Campus Supports

Students are strongly encouraged to meet course instructors and TA's during office hours for assistance in course-content, understand the course's expectations from enrolled students, etc. Beyond the course, students are also encouraged to use a variety of other resources. (Instructors are also encouraged to refer students to these resources when needed.) These resources include Counseling and Psychological Services/CAPS (for mental health), LUMS Medical Center/LMC (for physical health), Office of Accessibility & Inclusion/ OAI (for long-term disabilities), advising staff dedicated to supporting and guiding students in each school, online resources (https://advising.lums.edu.pk/advising-resources), etc. To view all support services, their specific role as well as contact information click here (https://advising.lums.edu.pk/#supportservices).

Academic Honesty/Plagiarism

LUMS has zero tolerance for academic dishonesty. Students are responsible for upholding academic integrity. If unsure, refer to the student handbook and consult with instructors/teaching assistants. To check for plagiarism before essay submission, use similarity@lums.edu.pk. Consult the following resources: 1) Academic and Intellectual Integrity (http://surl.li/gpvwb), and 2) Understanding and Avoiding Plagiarism (http://surl.li/gpvwo).

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LUMS Academic Accommodations/ Petitions policy
Long-term medical conditions are accommodated through the Office of Accessibility & Inclusion (OAI). Short-term emergencies that impact studies are either handled by the course instructor or Student Support Services (SSS). For more information, please see Missed Instrument or 'Petition' FAQs for students and faculty (https://rb.gy/8sj1h)

LUMS Sexual Harassment Policy
LUMS and this class are a harassment-free zone. No behavior that makes someone uncomfortable or negatively impacts the class or individual's potential will be tolerated.

To report sexual harassment experienced or observed in class, please contact me. For further support or to file a complaint, contact OAI at oai@lums.edu.pk or harassment@lums.edu.pk. You may choose to file an informal or formal complaint to put an end to the offending behavior. You can also call their Anti-Harassment helpline at 042-35608877 for advice or concerns. *For more information: Harassment, Bullying & Other Interpersonal Misconduct: Presentation (http://surl.li/gpvwt)*

Course Overview			
Week#	Topics	Readings	CLOs
1	Time evolution operator, Heisenberg picture	Ch 2	3
2-5	QM in 3D and the Hydrogen atom, angular momentum and spin. addition of angular momentum and the Clebsch-Gordon coefficients	Ch 3	1
6-9	Perturbation theory (time independent and time-dependent), the variational method	Ch 5	2
10-11	Symmetries and conservation laws. Discrete symmetries	Ch 4	3
12-13	Entanglement and the Bell's inequality for spin ½, Introduction to the density matrix formalism	Ch 3	3

Textbook(s)/Supplementary Readings	
1	**Modern Quantum Mechanics**, JJ Sakurai and J Napolitano.
2	**Quantum Mechanics: A Paradigms Approach**, DH McIntyre. (In case you find Sakurai to be too terse and want something more verbose)
3	**Principles of Quantum Mechanics**, R Shankar. (In case you want a book that ensures you get all the technical details)
4	**Quantum Mechanics: Concepts and Applications**, N Zettilli. (In case you feel like practicing lots of problems)
5	**Introduction to Quantum Mechanics**, DJ Griffiths. (Great for perturbation theory)

Course Policies	
Late Assignment	Late assignments shall not be accepted.
Missed Assignment	Catered to by the N-X policy.
Missed Quiz	Catered to by the N-X policy.
Missed Exam	Please petition the OSA in case of a missed exam.