Course Syllabus **Advanced Quantum Mechanics** **Fall**

Instructor: M. A. K. Lodhi E-mail: a.lodhi@umt.edu.pk Telephone: 3487

Office Hours: Friday: 9 - 9:30 PM, Monday 10:00 – 11:00 AM and any other time by appointment or walkin

Course Objective: To develop skill to translate between descriptive, pictorial, graphical and mathematical representation of the same concept in problem-solving strategy. Students will learn laws of motion and conservation laws and apply them in solving problem with respect to quantum mechanical phenomena. Quantum Mechanics is abstract and mathematical in origin. Its use makes things understand at micro level by applying its laws in solving problems. Learning techniques of quantum mechanics is not the sole objectives of this course. **Learning techniques of quantum mechanics for problem solving and its application is the main objective of the course.**

Learning Outcome: We will record the students' responses during the course of lecture to assess their learning outcome. Accordingly certain questions in the exams will explicitly require the course objective to use as learning assessment tools.

Course Coverage: Topics selected from:-- Appropriation: Perturbation Theory, harmonic perturbation, emission and Absorption of Radiation, Spontaneous Emission, Stark Effect, Variational Principle, H-molecule ion, Ground state of ^{4}He, WKB Appropriation, Classical region, Tunneling Effect, Symmetry, conservation laws, discrete Symmetries (time, surreal, Lattice translation), internal symmetries is spin. Second Quantization, Path Integral, Relativistic wave equation: Klein Gordon Equation, Dirac Equation, Lorentz–Covariance

Grades: The course grade will be determined from mid test, final, homework, quizzes, attendance, and class participation and discussion.

The grade scale will be approximately: A≥90>B≥80>C≥70>F

Homework: Doing the homework is very important for success in this course and building the strong foundation. Examination grades generally reflect how well one understood the material and did the homework. The homework will be assigned on the ***material covered and to be covered in the class.*** Based on the lecture and homework a short quiz will be given on regular basis.

Quizzes and Examinations: The examinations are closed book. One may use in the exam a 3" x 5" card with the material of one's choice. Only **simple calculators** without any material stored are allowed. The test/test will last for 5 to 30 minutes.

Makeup exam and quiz: Makeup quizzes and the exams **will not be given.** In a serious emergency, however, please contact me to find out how a missing grade for an exam may be determined.

IMPORTANT: Experience shows that average student **must spend *at least* 3 hours for homework for each hour of** lecture presentation. Planning wisely on dividing the time on learning material from lecture notes, the textbook, and doing the homework is important. Make notes carefully. **I encourage for questions and discussions in the class.** Review the new material in the textbook and do homework before going to each class.

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NOTE: Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact me as soon as possible so that necessary arrangements can be made.

Course Code: PH-6012
Course Title: Advanced Quantum Mechanics
Program: Ph.D./MS (PH)

Course Outline (Semester: Fall 2022)

Lecture Schedule	Friday: 06:00 pm-09.00 pm	**Pre-requisite**	Graduate Level Standing with the customary undergraduate courses in advanced calculus, vector analysis and an introductory course in quantum mechanics.

Course Instructor	M. A. K. Lodhi	**Contact**	a.lodhi @umt.edu.pk 0307 444 1854
Course Description	The advanced course in quantum mechanics has been a time-honored part of the graduate physics curriculum. It remains an indispensable part of the physicist's education. Quantum mechanics is the basis of our understanding of all natural phenomena. It plays a fundamental role in preparing the student for the study of modern physics. At the beginning of the twentieth century, physics was marked by the profound upheaval that led to the introduction of quantum mechanics. The classical laws of physics were found to be wanting on an atomic and subatomic scale. The study of blackbody radiation led to suggest the hypothesis of quantization of energy in 1900. Although it seems *a priory* irreconcilable, a complete interpretation of phenomena can be obtained by conserving the both the wave aspect and the particle aspect of light. This apparent paradox can be resolved by the introduction of quantum concepts. The present approach that we take is an attempt at an exposition of quantum mechanics, which does fulfill the new requirements. Those formulations and mathematical techniques which are of importance for modern physics receive great deal of emphasis in the syllabus of quantum mechanics.		
Expected Outcomes	At the completion of this course, the student is expected to: ➢ know the role and treatment of the wave function in quantum mechanics, ➢ use of the statistical interpretation of the wave function, ➢ understand the central role of the PROBABILITY that it plays in quantum mechanics, ➢ understand the normalization process of wave function, ➢ have clear concept of standard deviation and uncertainty principle, ➢ have clear understanding of conservation of momentum, angular momentum and energy, ➢ derive and apply wave functions to various problems, ➢ be familiar with use of approximations in quantum mechanics and perturbation theory.		
Text Book (TB) And Reference Book	**Text Book:** Quantum Mechanics by D. J. Griffiths 2nd. edition, **Reference Book:** 1. Quantum Mechanics by Cohen-Tannoudji 2. The principle of Quantum Mechanics by P. M. A. Dirac		
Assignments	1. Homework Assignments to be given regularly to be submitted on EVERY class meeting. 2. A term paper submitted and presented at the end of the semester	**Quizzes**	Quizzes (based on HW and previous lecture) will be given on every class meeting time. No make-ups will be offered for missed quizzes. They will be used for attendance as well.
Mid Term Examination	A60-minutes exam will cover all the material covered during the first half of the semester.	**Final Examination**	A 120-minutes exam will cover all the material covered during the semester.
Attendance Policy	Students missing more than 20% of the lectures will receive an "SA" grade in the course and will not be allowed to take final exam.		

Advanced Quantum Mechanics

Lecture Plan (Fall 2021)

Week	TOPICS	CHAPTER
1	Introduction, overview of introductory concept of quantum mechanics, historical aspects, laws of motion leading to Schrödinger equation	**0**
2	Probability and Statistical approach	**Ch. 1**
3	Bohr atom and spectral lines	**Notes**
4	Schrödinger equation in one dimension	**Ch. 2**
5	Formalism	**Ch. 3**
6	Schrödinger equation in three dimensions	**Ch. 4**
7	Harmonic Oscillator	**Ch. 2**
8	Addition of angular momentum	**Ch. 4**
9	Addition of angular momentum	**Ch. 4 + Notes**
10	Exercise	
11	Perturbation theory	**Ch. 6, 9**
12	Perturbation theory	**Ch. 9**
13	Scattering	**Ch. 11**
14	Comprehensive approach for solving problems	**All chapters + Notes**
15	Comprehensive approach for solving problems	**All chapters + Notes**
16	Term paper presentation	