PH 411/511 INTRODUCTION TO QUANTUM MECHANICS

Fall-2007
Room SB2 -101
Tue & Th 16:00-17:50 PM
http://www.physics.pdx.edu/~larosaa/

Dr. Andres La Rosa
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Office hour: F 14:00-15:00

Textbook: **R. Eisberg and R. Resnick, "Quantum Physics,"** 2nd Edition, Wiley, 1985. This good reference should fit very well for both students from engineering and physics majors**.**

We will complement the material with our own **lectures notes**, prepared particularly to cover the topics no extracted directly from the textbook above but particularly from: **Richard Feynman, "The Feynman Lectures on Physics," Volume III**, Addison Wesley, 1989. This reference will be used very much in the first part of the course.

Students who already have the book written by Feynman may not need to buy the textbook by Eisberg and Resnick cited above. In fact, the Feynman book can be complemented with any other Quantum Mechanics book available in the PSU Library. Some particular good quantum mechanics books references are: **B. H. Bransden and C. J. Joachain, "Quantum Mechanics**, Prentice Hall (2000); or **D. J. Griffiths,"Introduction to Quantum Mechanics,"** Pearson Prentice Hall (2005).

The first three books cited above will be available in the Library Reserved Room.

Grading:

Homework	**30%**	To be assigned regularly, alng the lecture sessions
1st Exam	**30%**	Tuesday, October 29th Time 16:00
Final exam	**40%**	Tuesday, December 4th, Time 15:30

95-100 A	90-94 A-	85-89 B+	80-84 B	75-79 B-
70-74 C+	65-69 C	60-64 C-	55-59 D+	50-54 D

Lecture Notes Lectures notes that cover those sections of the course prepared following the Feynman textbook will be available at http://www.physics.pdx.edu/~larosaa

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SYLLABUS

SECTION- I: The TRANSITION from CLASSICAL to QUANTUM PHYSICS

CHAPTER-1 ABOUT THIS COURSE

Introduction, philosophy of the course, course organization

CHAPTER 2 CLASSICAL PHYSICS (REVIEW)

2.1 Electromagnetism

(The Maxwell's equations, light as electromagnetic radiation, Michelson-Morley experiment, Lorentz' length-contraction hypothesis, the Lorentz' transformation.)

2.2 Special theory of relativity

(Electromagnetism and the principle of relativity, Einstein's principles of relativity, relationship of space-time coordinates in different inertial reference frames, required modification of the classical mechanics laws for compatibility with the relativity principles, relativistic mass, four-components vectors and symmetry

CHAPTER 3 THE ORIGINS OF QUANTUM PHYSICS

3.1 Black body radiation

(Thermal equilibrium of radiation, classical approach to calculate average energy, Planck's hypothesis to calculate average energy.)

3.2 Particle-like properties of radiation

3.3 Wave-like properties of particles

3.4 Wave-particle duality

SECTION II: THE HEISENBERG's PRINCIPLE and THE CONCEPT OF AMPLITUDE PROBABILITY

CHAPTER-4 WAVEPACKETS: DESCRIPTION OF THE FREE PARTICLE MOTION

4.1 Spectral Decomposition of the wavefunction (relative to base states) (The scalar product, spectral decomposition using complex variable: the Fourier transform, brackets notation.)

4.2 Phase Velocity and Group Velocity

Planes, traveling plane waves, phase velocity, Group Velocity

4.3 Description of a free-particle motion

(Wavefunction with a definite momentum, a wavepacket as a wavefunction.)

CHAPTER-5 QUANTUM BEHAVIOR: The WAVE-FUNCTION and the UNCERTAINTY PRINCIPLE

5.1 Quantum behavior of particles passing through two slits
(The concept of Probability, contrast between experiments with bullets light, attempts to track electrons' trajectories

5.2 The Heisenberg's Uncertainty Principle

5.2.A Uncertainty in the position Δx and linear momentum Δp.

5.2.B Use of the grating resolving power to show the uncertainty the measurement of the energy content ΔE of a pulse and the time Δt required for the measurement. Gratings, phasors (addition of multiple waves), gratings and spectral resolution, condition for the minimum length time Δt required for the measurement of the energy E with a resolution ΔE.

5.2.C. Uncertainty principle and the resolving power of a microscope. Image formation and the resolving power of a lens. Watching electrons through the microscope

5.3 Interpretation of the Wavefunction
The need of a wavepacket (rather than a single harmonic function) to describe a free particle motion, Einstein's interpretation of the granularity of the electromagnetic field, Max Born's probabilistic Interpretation of the wavefunction, the concept of ensemble. The philosophy of Quantum Theory

CHAPTER-6 THE AMPLITUDE PROBABILITY

6.1 Quantum mechanics description in terms of base-states

6.2 Probability amplitude

6.3 General guiding principles to assign amplitude probabilities

6.4 Interference between Amplitude Probabilities

6.4.1 Two-slit experiment: Watching electrons' trajectories
Adding amplitude-probabilities for events producing the same final state. Adding probabilities for vents producing different final states.

6.4.2 Scattering from a crystal

6.4.3 Identical Particles

SECTION- III THE HAMILTONIAN OPERATOR

CHAPTER-7 THE HAMILTONIAN MATRIX
How Do States Change with Time?

7.1 What are the base states?

7.2 How do states change with time?

7.2.A The Evolution Operator

7.2.B The Hamiltonian Matrix

7.3 General characteristic of the Hamiltonian Matrix

73.A Symmetric components

7.3.B Stationary states