21002: Quantum Mechanics and Applications

July – November 2014

Objectives

1. To provide an understanding of elementary concepts of quantum physics, and it's various flavors. To justify why is quantum physics the predominant theory of nature?
2. To demonstrate the uses of quantum mechanics in different fields of science and engineering.

Contents

(1) Early development
- Failure of Classical Mechanics to explain microscopic phenomena
- Classical to quantum mechanics, Planck's quantum hypothesis
- Photoelectric effect, Compton scattering, Wave nature of matter
- Uncertainty principle

(2) Wave equation
- Schrödinger's time independent and time dependent wave equations

(3) Postulates of Quantum mechanics
- Postulates, Wavefunctions and probabilities
- Operators, Matrix representations, Commutators

(4) Exactly solvable problems
- Particle in a box, Tunneling
- One dimensional potential barriers and wells
- Harmonic oscillator

(5) Hilbert spaces
- Elementary introduction to Hilbert spaces
- Bras and Kets

(6) Special Theory of Relativity
- Lorentz transformation, Time dilation and Length contraction
- Energy mass equivalence, Four vectors

(7) Applications
- *Nuclear Physics*: Nuclear properties and decays, Meson theory of nuclear forces
  Tunnel theory of alpha decay.
- *Particle Physics*: Classification of elementary particles, Quarks and leptons
  Exchange bosons, Four fundamental interactions in nature
  Introduction to Large Hardon Collider (LHC).
- *Quantum Optics*: Introduction to concepts of coherent and squeezed states
  Poissonian distribution.
- *Quantum Information*: Introduction to the concept of a qubit
  von Neumann entropy, Bell states
  EPR Paradox and entanglement.

Learning Outcomes

1. Become familiar with the basic concepts of quantum Mechanics and some of its applications.
2. Should be able to judge the requirement and approach a problem quantum mechanically.

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Books

- Arthur Beiser, *Concepts of Modern Physics*, Tata Mcgraw Hill, 2008. (Textbook)
- D. J. Griffiths, *Introduction to Quantum Mechanics*, Pearson India, 2005.
- J. J. Sakurai, *Modern Quantum Mechanics*, Addison Wesley, 1993.
- C. Cohen-Tannoudji, B. Diu, and F. Laloë, *Quantum Mechanics I & II*, Wiley-Interscience, 1992.
- I. N. Levine, *Quantum Chemistry*, PHI Learning, 2009.

Homework Assignments

A total of 10 – 12 assignments will be given throughout the semester. Problem sets will be uploaded to the course website. The solutions will be discussed in the tutorial sessions. (Solving problems are important to gain confidence on the subject. Please do not copy!).

Quiz

There will be 3 – 4 surprise quizzes.

Evaluation

Homework Assignments	0%
Mid Semester I	20%
Mid Semester II	20%
End Semester	50%
Quiz	10%

Class

Lectures	11 AM (Monday, Wednesday, Friday)
Tutorial	
Office hour	2 – 4 pm, Friday
Room	

Instructor

Manikandan Paranjothy (pmanikandan@iitj.ac.in, Phone: 282, Room No. 3103, Admin. Block)

Tutors

Manikandan Paranjothy (pmanikandan@iitj.ac.in)
Ashutosh Kumar Alok (akalok@iitj.ac.in)
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Course website

http://home.iitj.ac.in/~pmanikandan/Courses/PhysicsIII/index.html

http://home.iitj.ac.in/~dk/moodle/