Physics PH 4713/6713
Introduction to Quantum Mechanics

Instructor:
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Time and Location:
9:30 am-10:45 pm
Tuesday and Thursday
HILBUN Hall 152

Office hours: Walk in at any time.

Pre-requisite:

PH 3613 (Modern Physics) and MA 3253(Differential Equations)

Text Book:

Introduction to Quantum Mechanics by David J Griffiths, 2nd Edition (2005), Pearson publishing.

Reference Books put on reserve in the library:

J.J. Sakurai , Modern Quantum Mechanics, (Revised edition)

Cohen-Tannoudji, et.al , Quantum Mechanics, Vol. I and II (1977)

Grading information:

There will be a mid-tern and a final exam and 6 homework sets:

(1) Mid-term exam, 20 %

(2) Final exam, 20 %

(3) Homework: 10 % $\times$ 6= 60 %.

A letter grade will be given as your final grade

Any adjustments can be made on the following tentative syllabus depending on students' feedbacks. Any suggestions from students are welcome

Chapter 1, Prelude: The birth of Quantum Mechanics (1 lecture)

Historical developments leading to the Schrodinger wave equation and some general concepts in quantum mechanics. Brief review on several experimental phenomena motivating a quantum theory of the microscopic world: black-body radiation, photo-electric effect, line-spectrum of atoms, stability of an atom, Planck-Einstein-Bohr's old quantum theory, de Broglie's wave-particle duality.

Chapter 2, The Schrodinger wave equation (2.5 lectures)

- Heuristic derivation of the Schrodinger wave equation of a particle with mass m moving in a potential $V(x)$, Wave function and its probability interpretation,
- Measurement theory, wave-function collapse after a measurement, 3 school of thoughts: Realist position, Orthodox position and Agnostic position.
- Normalization, position, momentum, kinetic energy and potential energy
- Continuity equation, conservation of probability

Chapter 3, One dimension problems

- Solving the Schrodinger wave equation in various one-dimensional potentials, separation of variables, eigenvalues and eigenfunctions, superposition principle, parity operator
- Bound states in an infinite square potential, a finite square potentials, a δ function well, an harmonic oscillator
- Scattering states, transmission and reflection in a finite square potential and a δ function barrier
- Zero point motions, Bohr's correspondence principle, crossover from quantum to classical at large quantum numbers
- General one dimensional scattering theory from probability conservation (unitary) and Time reversal symmetry

  Upto here 12 lectures
- Free particle wavefunction, Wave Packet, group velocity versus phase velocity, (1.5 lecture)

Chapter 4, Variational principle and its applications to one-dimensional problems, (1.5 lecture)

Chapter 5, Operator method and matrix formulation in quantum mechanics (10 lectures)

- Inner product of two wavefunctions, Schwartz inequalities, operators, commutators, Jacobi identity, inverse, complex conjugate, transpose, Hermitian conjugate, Hermitian operators
- Properties of Hermitian operators
- Mutually commuting Hermitian operators: angular momentum, simultaneous eigenvalues and eigenfunctions of angular momentum and Hamiltonian,
- Mutually non-commuting operators: Heisenberg uncertainty relations, coherent state, energy-time uncertainty relations, Virial theorem.
- Hilbert space, representations, complete basis, vectors, matrices, change of basis, unitary transformation, unitary matrix
- Matrix formulations of quantum mechanics: Eigen-values and eigen-vectors, Diagonization of a matrix, characteristic equation, constructing unitary matrices from eigne-vectors.
- Dirac notations, bras, kets, coordinate representation, momentum representation, Fourier transform.