QM-Course-Handout

Quantum Mechanics-I

A course given at IIT Bhubaneswar, Jul-Nov 2017

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Contents

§1 Syllabus

The course will be covered in seven parts. The syllabus for different parts is as follows.

1. **Part-I Rise of Quantum Theory**
   Inadequacy of classical theories. Landmarks in rise of quantum theory. Review of classical and quantum particle and wave concepts. Uncertainty principle. The changes and new concepts brought in by quantum theory. Wave mechanics of a single point particle.

2. **Part-II Wave Mechanics of a Point Particle** Optics and mechanics analogy. Time dependent Schrodinger equation. Conservation of probability. Interpretation of wave function as probability amplitude. Probability current density. Schrodinger equation for a charged particle. Time reversal. Free particle. Solution of time dependent Schrodinger equation for a free particle. Wave packets. Periodic boundary

condition and box normalization. Free particle in two and three dimensions. Eigenfunctions of momentum. Momentum space wave function. Quantum mechanics of a spin half particle.

3. **Part-III Motion of a particle in potential well.**
   Particle in a box. Boundary and matching conditions on wave function. Energy eigenvalues and eigenfunctions. Harmonic oscillator energy eigenvalues and eigenfunctions. Periodic potential Reflection and transmission through a potential well. Barrier tunnelling. General properties of motion in one dimension.

4. **Part-IV Spherically symmetric potentials in three dimensions.**
   Conservation of angular momentum. Reduction of two body central force problem to one body with reduced mass. Separation of variables in spherical polar coordinates. Solution of radial equation for free particle and piece wise constant potentials. Hydrogen atom energy levels and wave functions. Accidental degeneracy of Coulomb energy levels.

5. **Part-V General principles of quantum mechanics.**
   The structure of physical theories. Thought experiments and superposition principle in quantum mechanics. States and dynamical variables in quantum description of a physical system. Probability and average value. Canonical quantization. General form of uncertainty principle. Time evolution. Schrodinger, Heisenberg, and Dirac Pictures in quantum mechanics. Density matrix. Identical particles

6. **Part-VI Matrix mechanics**
   Harmonic oscillatorenergy levels. Angular momentum eigenvalues and eigenfunctions.

7. **Part-VII Working with representations**
   Compatible variables. Commuting observables. Complete commuting set. Functions of operators and matrices. Simultaneous eigenvectors as basis in Hilbert space. State vectors as set of probability amplitudes. Examples.

§2 Class Room Lectures

Each lecture will consist of three sessions.

1. Recall and Understanding of Prerequisites:
   In the first session the prerequisites will be listed and discussed.

2. Main Lectures
   The second session will consist on main lecture.

3. Discussion and Suggestions for Further Study 1. References used in the lecture
   2. References recommended for further study

§3 Evaluation and Grading

Very briefly the evaluation will consist of

- End Semester Examination 50%
- Mid Semester Examination 30%
- Activities during the course work 20%

Very briefly we will have the following types of activities.

§4 Continuous Assessment

Continuous assessment will based on a variety of activities indicated below.

- Recall and Understanding
- Completing Details
- Application and Analysis
- Synthesis
- Judgement
- Reading Assignments
- Initiative and Creativity

Details of activities and of continuous evaluation process will be made communicated separately.

§5 Course Site:

All study material will be made available on the following two sites.

http://physics-lessons.globalcloudhost.com
http://0space.org/users/kapoor

You must visit these sites regularly.Important announcements will be put up there and activities will be assigned there