Quantum Mechanics I - Web course

COURSE OUTLINE

The course is a one semester first course on Quantum Mechanics at M.Sc. Level. Together with a course Quantum Mechanics - II, this satisfies the requirement for the Master's program in physics.

The course begins with a review of old quantum theory and concepts like wave particle duality. The Copenhagen interpretation of wavefunction and basic postulates of Quantum Mechanics are introduced.

A short introduction to linear algebra with formal properties of wavefunctions and operators in the Hilbert space are discussed. The course then discusses some standard problems in one, two and three dimensions, such as step and barrier potentials, delta-function potential, harmonic oscillator, hydrogen atom etc. Some special topics such as spin of an electron, charged particle in an electric field and different representations are considered.

COURSE DETAIL

S.No	Topics	No. of Hours
1	**Prelude to Quantum theory:** Classical physics, Newtonian mechanics, gravitation and electromagnetic fields, microscopic description in terms of statistical mechanics.	**2**
2	**Introduction to quantum ideas:** a. **Photoelectric effect:** Particle nature of radiation, photons. b. **Compton effect:** Scattering of radiation as particles. c. **Diffraction of matter particles:** de Broglie wavelength. d. **Black-body radiation:** Distribution of intensity, Planck's hypothesis. e. **Atomic spectra:** Ritz combination principle, Balmer and other series, Rutherford model. f. **Bohr model:** Quantization of angular momentum, Bohr energies, Sommerfeld's generalization.	**6**
3	**Elements of Quantum mechanics:** a. A thought experiment, wave function and wave equation. b. Postulates of quantum mechanics: wave functions, Schroedinger equation, observables and operators.	**5**

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Physics

Pre-requisites:

None, but an exposure to modern physics is desirable.

Additional Reading:

1. A. K. Ghatak and S. Lokanathan, "Quantum Mechanics : Theory and Applications", 5th Edition, McMillan India, New Delhi (2005)

Hyperlinks:

http://ocw.mit.edu/OcwWeb/Physics/8-05Fall-2004

Coordinators:

Prof. S.H. Patil
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	c. Formal properties of wave functions: Hilbert space of linear vectors, scalar product, operators and their adjoints, Hermitian operators, eigenvalues and eigenvectors.	
4	**Quantum mechanics in 1-dimension:** a. Free particle and wave packet, completeness. b. Uncertainty principle, minimum uncertainty, Ehrenfest's theorem, E.P.R. paradox. c. Step potential, transmission and reflection coefficients, transfer matrix. d. Particle in a well/box, density of states, correspondence principle. e. Delta-function potential, transmission and bound states. f. Simple Harmonic Oscillator potential, scaling, virial theorem, Feynman-Hellmann theorem. g. Bound states in weak potentials.	**7**
5	**Quantum mechanics in 2-dimension:** a. Curvilinear coordinates, angular momentum. b. S. H. O. potential, isotropic and non-isotropic, $1/r^2$ correction. c. Coulomb potential, $1/r^2$ correction, angular confinement.	**5**
6	**Quantum mechanics in 3-dimension:** a. Central potential, angular momentum. b. Solutions for the angular part. c. Some properties of P_l , Y_l^m functions. d. Angular momentum algebra. e. Free particle in 3-d. f. Particle in a spherical box. g. Positive energy states, scattering. h. Particle in a S.H.O potential, threshold, $1/r^2$ correction. i. Particle in a Coulomb potential, virial theorem, F-H theorem, $1/r^2$ correction.	**8**
7	**Miscellaneous topics:** a. Spin of an electron. b. Charged particle in an e.m. field. c. Different representations.	**6**

	Total	39

References:

1. D. J. Griffiths, "Introduction to Quantum Mechanics", 2nd Edition, Benjamin Cummings (2004)
2. R. Shankar, "Principles of Quantum Mechanics", Springer (1994)
3. J. J. Sakurai, "Modern Quantum Mechanics", Addison Wesley (1998)
4. L.D. Landau and L. M. Lifshitz, "Quantum Mechanics - Non-relativistic Theory" , 3rd Edition, Elsevier Science (1977)
5. E. Merzbacher, "Quantum Mechanics", 3rd Edition, John Wiley (1998)
6. L.I. Schiff, "Quantum Mechanics", 3rd Edition, McGraw Hill (1968)