Quantum Mechanics I - Video course

COURSE OUTLINE

Basic concepts of quantum mechanics and mathematical preliminaries, Eigenvalues, expectation values, Measurement and the uncertainty principle, Time evolution of wavepackets, 1-dimensional potential well problems, Simple harmonic oscillator Central force problems, Orbital angular momentum and spin, Hydrogen atom.

The deuteron, Invariance principles and conservation laws, Charged particle in magnetic field, Schrodinger, Heisenberg and interaction pictures, Elements of perturbation theory.

COURSE DETAIL

1. Motivations for studying quantum mechanics.
2. Basic principles of quantum mechanics,Probabilities and probability amplitudes.
3. Linear vector spaces , bra and ket vectors.
4. Completeness, orthonormality, basis vectors.
5. Orthogonal, Hermitian and Unitary operators, change of basis.
6. Eigenvalues and expectation values, position and momentum representation.
7. Measurement and the generalized uncertainty principle.
8. Schrodinger equation, plane wave solution.
9. Probability density and probability current
10. Wavepackets and their time evolution.
11. Ehrenfest relations.
12. 1-dimensional potential well problems, particle in a box.
13. Tunnelling through a potential barrier.
14. The linear harmonic oscillator; Operator approach.
15. The linear harmonic oscillator and the Hermite polynomials.
16. Coherent states and their properties. Application to optics.
17. Other interesting superpositions of basis states such as squeezed light.
18. Motion in 3-dimensions; The central potential problem.
19. Orbital angular momnetum and spherical harmonics I.
20. Orbital angular momnetum and spherical harmonics II.
21. Hydrogen atom ; its energy eigenvalues and eigenfunctions.
22. Additional symmetries of the hydrogen atom.
23. The deuteron ; Estimation of the size of the deuteron .
24. The isotropic oscillator, energy degeneracy.

NP-TEL

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Physics

Pre-requisites:

Some knowledge of classical mechanics will be helpful.

Coordinators:

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25. Invariance principles and conservation laws.
26. Spin and the Pauli matrices.
27. Addition of angular momentum I.
28. Addition of angular momentum II.
29. The spin-orbit coupling and its consequences.
30. Charged particle in a uniform magnetic field; Energy eigenvalues and eigenfunctions.
31. The Schrodinger, and Heisenberg pictures, Heisenberg equations of motion.
32. The interaction picture.
33. The density operator; pure and mixed states, with examples.
34. An introduction to perturbation theory; its relevance, and physical examples.
35. Time-independent perturbation theory : non-degenerate case.
36. Time-independent perturbation theory:degenerate case.
37. Time- dependent perturbation theory; atom- field interactions and the dipole approximation.
38. Examples of time-dependent calculations I.
39. Examples of time-dependent calculations II.
40. Summary of non-classical effects surveyed in the course.

References:

1. Sakurai, J.J., Modern Quantum Mechanics, Benjamin Cummings, 1985.
2. Merzbacher, E., Quantum Mechanics, 2nd Edn. Wiley International Edn., 1970.
3. Thankappan, V. K., Quantum Mechanics, Wiley Eastern Ltd., 1993.
4. R.P. Feynman, R.B. Leighton, and M. Sands, The Feynmam Lectures in Physics, Vol. 3, Narosa Publishing House, 1992.
5. Schiff, L. I., Quantum Mechanics, McGraw-Hill, New York, 1968.
6. Shankar, R., Principles of Quantum Mechanics, Plenum, New York, 1970.
7. Landau, L. D. and Lifshitz E. M., Quantum Mechanics, Pergamon, New York, 1974.
8. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill, 1977.