Approval : 10th Senate Meeting.

IIT Mandi
Proposal for a New Course

Course Name	: Special Topics in Quantum Mechanics
Course Number	: PH 613
Credits	: 3-0-0-3
Prerequisites	: First course on Quantum Mechanics and faculty consent
Intended for	: I-Ph.D., M.Sc., B.Tech 3rd and 4th Year.
Distribution	: Elective
Semester	: Odd/Even

Preamble: This course introduces some of the advanced level topics on quantum mechanics.

Course outline: The course begins a review of some of the basic concepts in quantum mechanics and then discuss the angular momentum algebra. It will then proceed to discuss the concepts in scattering theory, symmetry principles and second quantisation. Relativistic quantum mechanics will be introduced towards the end of the course.

Modules:

1. Review of basic concepts in quantum mechanics, measurements, observables and generalized uncertainty relations, change of basis, generator of translation

[6 lectures]

2. Angular Momentum: General theory of angular momentum, Angular momentum algebra, Addition of angular momenta, Clebsch-Gordon coefficients, Tensor operators, matrix elements of tensor operators, Wigner-Eckart theorem

[9]

3. Scattering Theory: Non-relativistic scattering theory. Scattering amplitude and cross- section. The integral equation for scattering. Born approximation. Partial wave analysis, optical theorem

[8]

4. Symmetries in Quantum Mechanics: Symmetry principles in quantum mechanics, conservation laws and degeneracies, discrete symmetries, parity and time reversal

[5]

5. **Second Quantization:** Systems of identical particles, Symmetric and antisymmetric wavefunctions. Bosons and Fermions. Pauli's exclusion principle, occupation number representation, commutation relations, applications of second quantization

[5]

Instructors may choose any one of the modules given below:

6. Elements of relativistic quantum mechanics. The Klein-Gordon equation. The Dirac equation. Dirac matrices, spinors. Positive and negative energy solutions, physical interpretation. Nonrelativistic limit of the Dirac equation

[7]

7. Quantum Information theory, Entanglément, EPR paradox Quantum cryptography [7]

Text Book:

1.Modern Quantum Mechanics - J J Sakurai(Addison Wisley, revised edition, 1993)

2. Advanced Quantum Mechanics, J J Sakurai (Pearson, First edition, 2002)

3. Quantum Mechanics, Cohen-Tannoudji, B Diu, F Laloe (Vol. II) (Wiley, second edition 1977)

References:

1. Quantum Mechanics-Vol.1 and II-Messiah (Dover Publications Inc., 2014)
2. Practical Quantum Mechanics - Siegefried Flügge (Springer 1994)
3. Many-electron theory-S. Raimes (North-Holland Pub. Co.1972)
4. Relativistic Quantum Mechanics-W. Greiner and D. A. Bromley (Springer, 3rd edition , 2000)
5. Quantum theory of many-particle systems- Fetter and Walecka (Dover Publications Inc2003)
6. Quantum Mechanics-Merzbacher (Third edition, Wiley, 2011)
7. Quantum mechanics-Landau and Lifshitz (Butterworth-Heinemann Ltd; 3rd Revised edition (18 December 1981)