M. Sc. I Year		MPH-C103			Semester-I
		QUANTUM MECHANICS – I			
Total Lectures	Time Allotted for End Semester Examination	Marks Allotted for Continuous Assessment	Marks Allotted for End Semester Examination (ESE)	Maximum Marks (MM)	Total Credits
60	**3 Hrs**	**30**	**70**	**100**	**04**

- ***Learning objectives***

The main objective of this course is to make students aware about the basic formulations in quantum mechanics. There are many different types of representations of state and operators that are very useful in studying the notions of quantum mechanics deeply. The course let know the students about the Schrödinger equation and its applications in diverse situations including bound state problems. The study of different types of operators such as Hermitian operators, unitary operator and angular momentum operator along with Eigen function and Eigen values are the integral part of this course. In this course, the students will also be able to study the wave functions of system of identical particles in greater detail.

NOTE: The question paper shall consist of two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer type questions of six marks each and student shall be required to attempt any five questions. Sec.-B shall contain 8 descriptive type questions of ten marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllbus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT-I

SCHRöDINGER WAVE MECHANICS AND APPLICATION

Motion of wave packet, Schrödinger equation, Normalised and orthogonal wave functions, Stationary state solution, Expectation values of dynamical variables, Probability current density, Ehrenfet's theorem, Momentum eigen functions and their applications, Coordinate and momentum representation, Rectangular potential barrier and its applications to α - decay, Particle in 1-D infinite deep potential well. **(12 Lectures)**

UNIT-II

BOUND STATE PROBLEMS

One dimensional and three dimensional harmonic oscillators, One dimensional finite square well, Spherically symmetric systems and potentials, Rigid rotator, Hydrogen atom and its normal state. **(12 Lectures)**

UNIT-III

OPERATORS

Algebra of operators, Linear operators, Eigen function and eigen values of operators, Orthogonal and complete set of eigen function, Dirac, Bra and Ket space, Heisenberg's uncertainty relations derived from operators, Hermitian operator and its properties, Matrix representation of operators, Change of basis functions, Unitary and similarity transformations, Equation of motion. Schrödinger, Heisenberg and interaction pictures. **(12 Lectures)**

UNIT-IV

ANGULAR MOMENTUM

Commutation Algebra, Commutation relation between position and momentum, Commutation relation for orbital angular momentum (L), Spin angular momentum (S) and total angular momentum (J), Eigen value spectrum for J^2 and J_z , Matrix elements of J_x, J_y, J_z, Addition of angular momentum. **(12 Lectures)**

UNIT-V

IDENTICAL PARTICLES AND SPIN

Physical meaning of identity, Exchange symmetry of wave functions, Symmetric and antisymmetric wave functions, Pauli's exclusion principle and its connection with statistical mechanics, Collision of identical particles, Spin angular momentum, Effect of spin on energy states of an atom (He-atom), Spin orbit interaction and spin correction, Symmetric and antisymmetric wave functions of hydrogen molecule (H_2). **(12 Lectures)**

Text Books / Reference Books

1. Quantum Mechanics - L. I. Schiff (McGraw-Hill)
2. Quantum Mechanics - Merzbacher
3. Quantum mechanics - B. Craseman and J D Powell (Addison Wesley)
4. Quantum Mechanics - Mathews and Venkatesan
5. Modern Quantum Mechanics - J.J. Sakurai

- ***Learning outcomes***

After taking this course students will be able to appreciate the beauty of quantum mechanics by knowing all types of representations of operators and ways to apply them in different problems. The most important thing students will learn from this course is how to solve the hydrogen atom problem by using quantum mechanics. Students will be knowing about different types of operators such as Pauli spin matrices and unitary operators which are very important in nuclear and particle physics as well as atomic and molecular physics. The students will know about total energy and wave function of identical particles with a clear picture of the wave function of fermions and bosons.