M. Sc. I Year		MPH-C203			Semester-II
		QUANTUM MECHANICS – II			
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**

NOTE: The question paper shall consist of three sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer type questions of 6 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.

Learning Objectives*- This is an advanced level course in Quantum mechanics which aims to teach about various approximation methods (including stationary state and time dependent perturbation theory) in physics to calculate the approximate values of energy for various quantum mechanical systems as well as to study various scattering processes. The notions of relativistic quantum mechanics with the establishment of Klein-Gordon (KG) equation and Dirac equation will be discussed in greater length. This course will let students appreciate the beauty of quantum mechanics in the form of the phenomenon like Born approximation and its validity*.

UNIT-I

PERTURBATION THEORY -I

Non-degenerate case, First order and second order stationary perturbation theory, Degenerate case, Zeeman effect (without electron spin), First order Stark effect in H-Atom. The Variation method and its application to ground state of He and Vander-Waals interaction. **(12 Lectures)**

UNIT-II

PERTURBATION THEORY -II

WKB approximation, Connection formula for barrier penetration, Application of WKB method to theory of α decay. The time dependent perturbation theory, Transition probaility, FG rule, Harmonic perturbation, Adiabatic and sudden approximation. **(12 Lectures)**

UNIT-III

SCATTERING THEORY

Laboratory and C.M. frames, Scattering cross section, Scattering by spherically symeteric potentials (partial wave analysis), Scattering by an attractive potential well, Scattering by a Coulomb field- Rutherford formula, Condition for validity of Born Approximation, Application of Born approximation : (a) Scattering by a square well potential (b) Scattering by a screened Coloumb field. **(12 Lectures)**

UNIT-IV

RELATIVISTIC QUANTUM MECHANICS

The Klien-Gordon equation, Dirac relativistic equation and its covariant form, Dirac equation for particle in E.M. field, Magnetic moment of electron, Existance of electron spin, Spin-orbit coupling, Solution of Dirac's equation for a central field (H-atom), Energy eigen values. **(12 Lectures)**

UNIT-V

SEMICLASSICAL THEORY OF RADIATION

Radiation theory- Interation of radiation with atom, Electron dipole transition and forbidden transition, Classical radiation field, Asymptotic form of radiated energy, Dipole radiation, Planck distribution formula, Application of radiation theory-selection rule for a single particle.

(12 Lectures)

Text Books / Reference Books

1. Quantum Mechanics - L. I. Schiff (McGraw-Hill)
2. Quantum mechanics - B .Craseman and J .D .Powell (Addison Wesley)
3. Quantum Mechanics - Mathews and Venkatesan
4. Principles of Quantum Mechanics - I.S. Tyagi (Pearson)
5. Modern Quantum Mechanics - J.J. Sakurai
6. Introduction to Quantum Field Theory, - Paul Roman (John Wiley)
7. Quantum Fields - N.N. Bigollubov & D.V. Shrikov
8. Introduction to Quantum Fiels Theory- Paul Roman

Learning outcomes:

After studying this course successfully, students can calculate the ground state and excited state energies of various real life systems by using Principle, WKB approximation and perturbation methods. Such descriptions are quite useful to explain various energy spectrums in atomic and molecular spectra. They will be knowing about scattering in two different frames and can easily calculate scattering amplitude and scattering cross section for different scattering process which are important in the nuclear and particle physics. For instance, with the understanding of Dirac equation for electrons (or fermions in general), they will be knowing about the presence of antiparticles (or antimatter in general) in our universe.