Teaching Plan of 4th Semester 2025-2026

Subject: Physics

Semester: FYUGP 4th Semester

Paper Name: Quantum Mechanics-I

Paper Code: PHY4400704MN

Total Number of Classes/Lectures: 45

Period: January-June

Total Credit: 4 (Theory 3 + Laboratory 1)

Existing Base Syllabus: HS Physics

Faculty: Dr. Manisha Phukan and Dr. Palash Jyoti Boruah

Lecture No.	Unit/Topic	Mode of Teaching	Assessment Method	Faculty
03	**Unit-I: Origin of Quantum Theory** Failure of classical theories, Explanation of blackbody radiation, Photoelectric effect, Compton Effect Particle nature of radiation, Bohr's correspondence principle.	Lectures Oral Questions-P Problem Solving Previous year Question paper solving	Sessional & Class-tests	Dr. Palash Jyoti Boruah
08	**Unit-II: Matter Wave and Wave-Particle Duality** Wave-particle duality and de Broglie wavelength, particle as matter wave, wave description of particles by wave packets; phase and group velocity	Lectures Oral Questions-P Problem Solving Previous year	Sessional & Class-tests	Dr. Palash Jyoti Boruah

	Experimental verification of matter wave, Davisson and Germer experiment Linearity and superposition principle, two slit experiments with electrons and photons	Question paper solving		
13	**Unit-III: Schrödinger Equation and Wave Function** Time dependent Schrödinger Equation, Time independent Schrödinger Equation; Physical interpretation and properties of wave function, continuity of a wave function, boundary conditions and emergence of discrete and continuous energy levels; probabilities and normalization in three and one dimension; equation of continuity, current density in both one and three dimensions. Applications of Time independent Schrodinger Equation in different problems like: (i) particle in a one dimensional infinite well (quantum dot as an example) (ii) Particle in a one dimensional finite square potential well (iii) barrier penetration problems-potential step and rectangular potential barrier (tunnel effect) (iv) linear harmonic oscillator (v) spherically symmetric potential for hydrogen atom-radial solution, spherical harmonics, angular momentum operator and different quantum numbers, radial distribution function and shapes of the probability densities for ground and first excited states; degeneracy for states: s, p, d states.	Lectures Oral Questions-P Problem Solving Previous year Question paper solving	Sessional & Class-tests	Dr. Manisha Phukan
10	**Unit-IV: Stationary States and General Solutions**	Lectures Oral Questions-P	Sessional & Class-tests	Dr. Manisha Phukan

	Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wave function as a linear combination of energy eigenfunctions General solution of the time dependent Schrödinger equation, discrete and continuous spectrum, wave function of a free particle, spread of Gaussian wave function in one dimension Fourier transforms and momentum space wave function.	Problem Solving Previous year Question paper solving		
07	**Unit-V: Dynamical Variables as Operators** Dynamical variables as operators, definition of an operator, different types of operators and their properties, position, energy and momentum operator; commutation relations. Introduction to Hilbert space, Dirac notation, eigenvalue and eigenfunctions; expectation value of an operator, orthonormality condition, Ehrenfest' s theorem.	Lectures Oral Questions-P Problem Solving Previous year Question paper solving	Sessional & Class-tests	Dr. Manisha Phukan
04	**Unit-V: Uncertainty Principle (wave-packet & operator formulation)** Uncertainty principle from wave packet description, Gaussian wave packet. Simultaneous measurement and uncertainty principle. General statement of Heisenberg' s uncertainty principle, different uncertainty relations for non-commuting operators.	Lectures Oral Questions-P Problem Solving Previous year Question paper solving	Sessional & Class-tests	Dr. Palash Jyoti Boruah

	Uncertainty relations involving canonical pairs, applications of the position-momentum uncertainty principle, application of energy-time uncertainty principle, Virtual particles and range of interaction.			
Sl. No.	**Experiment No. and Aim of the Experiment**		**Mode of Teaching**	**Faculty**
1.	1. Measurement of Planck's constant using blackbody radiation and photo-detector.		Demonstrating the concepts clearly. Engaging students in hands-on experimental work for better understanding	Dr. Manisha Phukan Dr. Palash Jyoti Boruah
2.	2. Photo-electric effect: Photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.			
3.	4. To determine the Planck' s constant using LEDs of at least 4 different colours.			
4.	11. To determine the wavelength of laser source using diffraction from single slit.			
5.	13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.			

Reference Books

1. N. Zettili, Quantum Mechanics, John Wiley & Sons (2001).

2. J. J. Sakurai and J. Napolitano, Modern Quantum Mechanics, Cambridge Univ. Press, 2020.

3. Y. R.Waghmare, Fundamentals of Quantum Mechanics, Wheeler publishing (2014).

4. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Pearson Education 2nd Ed. (2004).

5. D. J. Griffiths, Introduction to Quantum Mechanics, Pearson Education (2005).

6. A. K. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer (2002).

7. A. Bieser, Concepts of Modern Physics, McGraw Hill (2002).

8. H. C. Verma, Quantum Mechanics, TBS publications (2019).