Course name: Quantum Reality

Course number: PHYS-0332
Department: Physics
Faculty: For science majors
Requirement: Student must be very comfortable with +2 level Physics and Mathematics. It is preferable that the student has taken either of PHYS-0132 or PHYS-0232.

Objective:

The course starts with a semi-historical narrative of the failure of classical physics to explain the microscopic world and the eventual birth of quantum mechanics. The course then gradually develops the conceptual and mathematical tools to deal with the problems of the quantum world and finally provides few applications from the real world where quantum mechanics has been widely used. In addition to the theoretical developments, students will also perform experiments related to the concepts of quantum mechanics.

Syllabus:

Historical Perspective **[10]**Photoelectric effect, Bohr atom, Black body radiation, Planck's formula, de Broglie hypothesis, Compton effect, Electron double-slit experiment, Davisson-Germer experiment, Heisenberg's uncertainty principle.

Basics of Wave Mechanics[20]
Concept of wave function, Wave packets, Group and phase velocities, Principle of superposition, Schrodinger equation, Probabilistic interpretation of the wave function, Copenhagen interpretation, Quantum philosophy, Stationary states, Solutions of Schrodinger equation in one dimensional simple potentials (infinite square well and rectangular barrier potential), Quantum Tunneling.

Applications of Quantum Mechanics [20]
3-4 applications from the list below will be discussed based on the interests of the students.
Hydrogen atom: Central force problem, Reduction to 1 dimension, solutions of Schrodinger equation, shapes of orbitals,
Rotation of diatomic molecules: Model as a linear harmonic oscillator, energy quantization and normal modes of oscillations.

Scanning Tunneling Microscope: Basic working principle and estimation of tunnel current, Radioactive decay: estimation of lifetime, alpha decay , Biophysical systems, Astrophysical applications, Basics of spin and 2 state system with applications to quantum computation.