TCIS, Hyderabad

Course: Quantum Mechanics-I
Start Date: August 2022
Coordinates: Tuesday and Thursday between 8:30 am to 10.00 am, Classroom-1, Third floor
Instructor: Dr. Raghunathan Ramakrishnan (ramakrishnan@tifrh.res.in)

Syllabus:

1) **Fundamental concepts:** Stern-Gerlach experiment; State vectors and operators; Bra-Ket notation: Hilbert space, Inner products; Matrix representation: Eigenkets, Spin-1/2 system, Measurements: Observables, Compatible/Incompatible observables, Uncertainty relations; Change of basis: Transformation, Continuous representation: Position/Momentum representation, Dirac delta function, Gaussian Wavepackets

2) **Quantum dynamics:** Time evolution and Schroedinger equation: Energy eigenkets, Stationary/non-stattionary states, Spin precession; Schroedinger/Heisenberg picture: Ehrenfest theorem, Transition amplitude; Simple harmonic oscillator: Stationary states, Time-evolution; Wave mechanics: Probability density, Classical limit; Elementary solutions to Schroedinger wave equation: Free particles, Infinite-square well, Finite-square well, Transmission-Reflection problems Simple harmonic oscillator, Linear potential

3) **Theory of angular momentum:** Rotations: Finite/infinite rotations, Commutation; Spin-1/2 system; Pauli 2-component quantum mechanics; Continuous groups: SO(3), SU(3), Euler rotations; Density operators: Pure-vs-mixed ensembles, time-evolution of ensembles, Quantum statistical mechanics; Eigenvalues and eigenstates of angular momentum; Orbital angular momentum: Spherical harmonics; Central potential problems, Hydrogen atom; Angular momentum algebra: Angular momentum addition,Clebsh-Gordon coefficients; Oscillator model of angular momentum; Spin correlation measurements; Tensor operators: Wigner-Eckart theorem

4) **Approximation methods:** Time-independent perturbation theory; Time-dependent perturbation theory; Application of perturbation theory to higher-order effects in Hydrogen atom Degenerate and non-degenerate versions; Variational method; WKB method

Required Text

1. *Modern Quantum Mechanics,* J. J. Sakurai, JJ. Napolitano, Pearson (Edition-3, 2021, Cambridge University Press).

Evaluation Method:
Assignment (6x5=30%), closed-book mid-term exam (30%), closed-book final exam (40%).