Course Outline (TPG 565: Quantum Mechanics (4 credits))

1. Fundamental Concepts:
Review of linear algebra, Postulates, Observables, Measurements, Ehrenfest theorem, Uncertainty principle, Density matrix.
2. Quantum Dynamics:
Schrödinger picture, Heisenberg picture, Dirac/Interaction picture, Dyson series, Conservation of probability.
3. Harmonic Oscillator:
Dirac operator method, Uncertainty of energy eigenstates, Time evolution of ladder operators, Coherent states.
4. Symmetry:
Symmetry in classical physics, Review of group theory, Lie groups, Lie algebras and their representations, Symmetry in quantum mechanics, Discrete and continuous symmetries.
5. Theory of Angular Momentum:
Rotations and angular momentum, SO(3), SU(2) and Euler rotations, Spin-1/2 and spin-1 systems, Addition of angular momentum, Clebsch–Gordan coefficients.
6. Approximation Methods:
Time independent perturbation method: Non-degenerate and Degenerate Cases, Variational method, WKB Method, Time dependent perturbation theory.
7. Scattering:
Scattering amplitude, Partial wave analysis, Born approximation, Optical theorem, Lippmann-Schwinger equation and its formal solution.
8. Relativistic Quantum Mechanics:
Klein-Gordon equation, Dirac equation.
9. Identical Particles:
Bosons and fermions, Spin-Statistics theorem, Non-Standard statistics, Anyonic Statistics, Parastatistics.
10. Miscellaneous Topics:
Quantum Entanglement, Entanglement entropy, EPR Paradox, Bell's theorem.

References Books:

1. J. J. Sakurai, Jim Napolitano, Modern Quantum Mechanics.

2. Ramamurti Shankar, Principles of Quantum Mechanics.

3. Horatiu Nastase, Quantum Mechanics: A Graduate Course.