PHYS 4386 Quantum Mechanics 3 2023

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TEXTBOOKS:
There is no required textbook for this course. Course notes will be published online. However, you might want to consult some of the textbooks listed below:

1) J.J. Sakurai, *Modern Quantum Mechanics* (Addison-Wesley, 1994).
2) R. Shankar, *Principles of Quantum Mechanics* (Springer, 1994).
A book which does offer a lot of information about the mathematical framework of QM.
3) Albert Messiah, *Quantum Mechanics I+II* (North Holland Publishing).
A classic textbook, lots of examples, worth consulting. Recent single volume reprint available.

1. INTRODUCTION
   - Applications of Quantum Mechanics: Natural Phenomena and Quantum Technologies
   - Schroedinger equation, correspondence principle
   - Discrete and continuous problems: Matrix versus wave formulation
   - Continuity equation, expectation values, commutators
   - Stationary states, eigenvalue problem
   - Momentum representation

2. MATHEMATICAL FORMULATION OF QUANTUM MECHANICS
   - Dirac formalism: vectors, operators, basis, representations
   - Matrix quantum mechanics
   - The eigenvalue problem
   - The measuring process, Heisenberg uncertainty relation
   - Quantum statistics, density operators
   - Time evolution: Schroedinger and Heisenberg picture

3. PERTURBATION THEORY AND VARIATIONAL APPROACHES
   - Non-degenerate/degenerate perturbation theory
   - Variational principle
   - Helium atom

4. TIME-DEPENDENT PERTURBATION THEORY AND SCATTERING THEORY
   - Time-dependent perturbation theory
   - Transition probabilities, Fermi's golden rule
   - Scattering amplitude, Born approximation
   - Phase shifts and partial waves
   - Propagators
   - Lippmann-Schwinger Equation

5. IDENTICAL PARTICLES
    - Bose and Fermi statistics
    - Spin-Statistic theorem: Symmetric and antisymmetric wave functions
    - Pauli exclusion principle
    - Slater determinant
    - Ideal Fermi and Bose gas
    - Entanglement measures
    - Bell's inequalities