Physics 137A, Quantum Mechanics, Spring 2017

Instructor:

- Prof. Daniel Kasen (kasen@berkeley.edu) Office 405 Campbell Hall
- Prof. Office hours: Wed 1PM-2PM and Fri 11 AM - noon, **held in 431 Old LeConte**

GSIs:

- Siva Darbha (siva.darbha@berkeley.edu)
  - Office hours: Tuesdays 11:00 - 12:00 and Thursdays 2:00 - 3:00 in 109 LeConte
- Nathan Haouzi (nathanhaouzi@berkeley.edu)
  - Office hours: Thursdays 3:00 - 5:00 in 421 Birge

Lectures and Sections

- Lectures MWF 9-10 AM in 3 LeConte
- Section 101: M 2:00 - 3:00 PM in 107 GPB (Genetics and Plant Biology)
- Section 102: W 4:00 - 5:00 PM in 241 Cory Hall

Course Materials

- Please follow this link for topic outline and readings
- Find at this link various codes and movies from the class
- REVIEW of Part 1 of the class
- REVIEW of Part 2 of the class
- REVIEW of Part 3 of the class
- Slides from lecture on spherical harmonics

Main Course Text:

- David J. Griffiths, "Introduction to Quantum Mechanics" - Current version is second edition, but using the first edition should be fine.

Other recommended sources

- Bransden & Joachain, *Quantum Mechanics* - Similar content and level as Griffiths
- the *Feynman Lectures* are available free at this link (Links to an external site.)Links to an external site. - Good conceptual discussions of QM, though often on topics outside of the scope of the class.

- Shankar, *Principles of Quantum Mechanics* - is available to Cal students **Error! Hyperlink reference not valid.**. More advanced (graduate) level, with more thorough discussion of mathematical formalism.

Exam Dates **(contact the professor immediately if you have conflicts)**

- Midterm #1 Feb 22, 2017 - Wednesday, 5 - 7 PM
- Midterm #2: Mar 22, 2017 - Wednesday, 5 - 7 PM
- Final Exam: May 8, 2017 - Monday, 7 - 10 PM

Homeworks

- Problem sets will due most fridays at 5 PM and will be made available below (eventually with solutions)
- Late homeworks turned in one business day after the deadline (e.g., before Monday 5 PM for a Friday 5 PM deadline) will receive a 25% deduction. Late homeworks turned in 2 business days after the deadline will receive a 50% deduction. After that, homework will not be accepted.
- Your lowest homework score will be dropped, to account for unforeseen circumstances.
- You are encouraged to learn and work in groups with classmates on the homeworks, but the solutions you turn in must be your own.

Grading

- problem sets (25%)
- midterm exam #1 (20%)
- midterm exam #2 (20%)
- final exam (35%)

All students who have special needs can receive appropriate accommodations by making arrangements though **Error! Hyperlink reference not valid.**

All students are held to the Student Code of Conduct

Course Topics and Recommended Reading

Below is a tentative list of topics; the schedule may be adjusted as course proceeds.

Recommended readings refer to sections in course text:

David Griffiths: "Introduction to Quantum Mechanics", Second Edition

---------- Part 1: Schrodinger Equation and Wavefunctions ----------

Week 1 (Monday a Holiday)
- Introduction and logistics, background and motivations for QM
- Review of wave equations, complex numbers, dispersion relations

Week 2 (Griffiths Chapter 1, 2.1 and 2.2)
- Introducing and motivating the Schrodinger Eq.
- The wavefunction: probability distributions, expectation values, ...
- Solving the Schrodinger Eq. by separation of variables
- Solution of S.Eq - Infinite square well

Week 3 (Griffith 2.4)
- Superposition of states and quantum time evolution
- Quantum operators and eigenvalue problems
- Quantum measurement
- Solution of S.Eq - Free Particle
- Wave packets and Fourier transforms
- The double-slit experiment

Week 4 (Griffiths 2.5)
- Solution of S.Eq - Delta function potential
- Boundary conditions of S.Eq
- Solution of S.Eq - Potential step
- Quantum tunnelling through classical forbidden regions

Week 5 (Griffiths 2.6) -- Monday a Holiday
- Solution of S.Eq - Finite Square well
- Bound versus scattering states
- Sketching wavefunctions

---------- Part 2: Quantum Formalism ----------

Week 6 (Griffiths Appendix A.1-A.3) Midterm #1 on Wednesday
- Introduction to finite vector spaces
- Inner products
- Linear transformations, Hermetian and Unitary

Week 7 (Griffiths Appendix A.4-A.5)
- Eigenvalue problems and basis states
- Projection operator
- Spin and the Pauli matrices

Week 8 (Griffiths 3.1-3.4)
- Function spaces (Hilbert Spaces)

- Momentum, position, and energy representations
- The Uncertainty principle.

Week 9 (Griffiths 3-5-3.6, 2.3)
- Harmonic oscillator with operators
- The time evolution operator, connection to Schrodinger Equation
- The space translation operator and connection to momentum
- Symmetries and conserved quantities

---------- Part 3: Quantum Mechanics in 3D and atoms ----------

Week 10 (Griffiths 4.1) Midterm #2 on Wednesday
- Quantum mechanics in 3D, separation of variables
- Spherical coordinates, angular and radial equations
- Spherical harmonics

= SPRING BREAK =

Week 11 (Griffiths 4.2, 4.3)

- The hydrogen atom, radial wavefunctions
- Angular momentum in quantum mechanics

Week 12 (Griffiths 4.4, 5.1)
- Spin angular momentum
- Multi-particle quantum mechanics
- Indistinguishability and the Pauli exclusion principle

Week 13 (Griffiths 5.2)
- Atomic structure and transitions
- Molecules

Week 14
- Interpretations of Quantum mechanics
- Copenhagen interpretation, Hidden variable theories, Many-worlds theories
- Quantum entanglement and the EPR experiment