Introductory Thermodynamics and Quantum Mechanics (Spring 2018)

Physics 5C, Spring 2018

Instructor:

- Prof. Daniel Kasen (kasen@berkeley.edu, office 405 Campbell Hall)
- Prof. Office hours: Wed: 1-2 PM and Fri: 10:11 AM in 431 LeConte (Wick Haxton's office)

GSI:

- Nicolas Ferland (nicolas.f@berkeley.edu)
- Office hours and location: Wed: 2-3 PM in 420J Leconte

Meetings:

- Lectures MWF 9-10 AM in 3 LeConte
- Section 101: W 4:00 - 5:00 PM in Dwinelle 88
- Section 102: Th 5:00 - 6:00 PM in Moffitt Library 103

Course Schedule and Materials

- Lecture Schedule and Readings
- Summary Notes on Part 1
- Slides and Codes
- Recommended Textbook #1: "Introduction to Quantum Physics", French and Taylor (Links to an external site.)Links to an external site.
- Recommended Textbook #2: "Concepts in Thermal Physics", Blundell and Blundell (Links to an external site.)Links to an external site., Second Edition

Other possible sources

- David J. Griffiths, "Introduction to Quantum Mechanics"
- Bransden & Joachain, *Quantum Mechanics*
- 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.

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

- Midterm #1 Wednesday, Feb 28 (5 - 7 PM) -- Midterm Solutions
- Midterm #2: Wednesday, Apr 11 (5 - 7 PM)

- Final Exam: Monday, May 7 (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 DSP (Links to an external site.)Links to an external site.

All students are held to the Student Code of Conduct

Lecture Schedule and Readings

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

Recommended readings refer to sections in course text:

F&T = French and Taylor "Introduction to Quantum Physics"

B&B = Blundell and Blundell "Concepts in Thermal Physics", Second Edition

------------ Part 1: Quantum Mechanics -----------

Week 1 (F&T 1.1 - 1.9)

- Introduction and course logistics
- Experimental evidence for QM: photoelectric effect, atomic spectra
- Bohr model of the hydrogen atom - quantization

Week 2 (F&T 2.1-2.3, 2.9-2.11, 3.1-3.3)

- Debroglie matter waves
- Wave equations and complex exponentials
- Dispersion relations, adding waves and group velocity
- Motivating the Schrodinger Equation

Week 3 (F&T 3.4-3.5, 3.10)

- Separation of variables and the time-independent Schrodinger Eq.
- Solving the Schrodinger Eq: 1D particle in an box
- Probabilistic interpretation of the wavefunction
- Calculating expectation values

Week 4 (F&T 8.1-8.3, 3.8, 3.11)

- Superposition of quantum states
- Time evolution of superposition states
- General superposition of particle in box states: Fourier series

Week 5 (F&T 8.5-8.9, 9.1-9.6)

- The free particle and particle wavepackets - Fourier series
- The uncertainty principle
- Solving the Schrodinger equation in regions of costant potential
- Applying boundary conditions (psi and dpsi/dx continuous)
- Reflection and transmission: Quantum tunnelling
- Bound states versus free (i.e., scattering) states

END MIDTERM #1 material

Week 6 (F&T 5.3)

- The time-independent Schrodinger Eq. as an eigenvalue problem
- Quantum operators: momentum, position, energy

Week 7

- Eigenvectors and basis
- The fundamental postulates of quantum mechanics

Week 8 ((F&T 5.1-5.7))

- Finite dimensional operators: spin
- The Schrodinger Eq. in 3D,
- Spherical harmonics
- The quantum hydrogen atom

------------ Part 2: Thermodynamics and Statistical Mechanics -----------

Week 9 (B&B Chapters 1,2,3)

- Conservation of energy, internal energy, and heat
- Basic properties of ideal gases (pressure, tempreature)
- Microstates and Macrostates, Evolution to Equilibrium
- Probability distributions, enumeration of microstates and entropy

Week 10 (B&B Chapters 4,5,6)

- Temperature and the 0th law of thermodynamics
- The statistical definition of temperature
- The Boltzman distribution

Week 11 (B&B Chapters 8,9,10.1-10.4,11)

- Kinetic Theory of Ideal Gases - Maxwell-Boltzmann distribution
- Information theory and Maxwell's Demon
- Particle mean free path and collisions
- Transport properties: diffusion and heat

Week 12 (B&B 12,13,14)

- First law of thermodynamics, functions of state, inexact differentials
- Reversible processes; adiabats and isotherms
- Second Law of Thermodynamics and Heat engines

END MIDTERM #2 material

------------ Part 3 Quantum-Statistical Mechanics -----------

Week 13 (B&B 15, 29, 30)

- Example systems: Spin and Paramagnetism
- Heat capacity and Einstein Solid
- multi-particle wavefunctions: bosons and fermions
- Blackbodies: Bose-Einstien and Fermi-Dirac distributions

Week 14 (B&B 36, 23)

- Entropy and the arrow of time
- Philosophical interpretations of quantum mechanics
- Quantum entanglement, EPR paradox
- Hidden Variables, Copenhagen interpretation, Many-worlds