Physics 491 - 2013

Atomic, Molecular, and Condensed Matter Physics

Monday, Wednesday, Friday, 1:50 - 2:40 pm, BPS 1420

Instructor: Mark Dykman, BPS 4244, ph. 884-5634
e-mail (preferred way of communication): dykman@pa.msu.edu
Office hours: Tuesday & Wednesday, 4:00 – 5:00 pm
Grader: Ding Wang
e-mail: wangdin1@msu.edu
Office hours: Monday 5:00 - 6:00 pm, Strosacker help room, 1248 BPS

Required Textbook: N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, any edition, but the more recent the better.
Recommended Textbook: C. J. Foot, *Atomic Physics*, (Oxford University Press, Oxford 2011).
Recommended Textbook: Your favorite textbook on quantum mechanics

Grading Scheme: biweekly problem sets — 20%
biweekly quizzes — 20%
midterm exam 30%
final exam — 30%.

Final grade will be calculated from the sum of the appropriately weighted percentage for each category, not from grades for each category.

Homework assignments will be given on Wednesdays and are due a week from the day they are given. There will be bi-weekly 15 minute long closed-book **one-problem quizzes** at the beginning of a class. At a quiz you will have to solve one problem out of the problem set that will be provided a week in advance.

Midterm exam: October 16, 1:50 to 2:40 pm, BPS 1420
Final exam: December 12, 12:45 pm to 2:45 pm noon, BPS 1420

Physics 491 2013

The goal of this class is to provide an insight into the basic properties of matter. We will go over the structure of atoms, how atoms combine into molecules, and what qualitatively new features emerge when atoms combine into a solid. The core topic is many-body physics, that is the physics of many interacting subsystems, such as individual electrons or, at the next level, atoms. It is truly remarkable that such complicated objects can be understood at all! Yet they can, as we will see.

Tentative Schedule

Date	Topic
Aug. 28 – Sep. 13	The hydrogen atom: Bohr's theory, the angular momentum, the radial Schrödinger equation, spin and spin-orbit interaction, the Zeeman effect
Sep. 16 – 27	Helium atom and the alkalis: the Pauli principle, exchange interaction, electron configurations and electron termsl
Sep. 30	Hyperfine structure. Atomic clocks
Oct. 2 – 14	Diatomic molecules: the Heitler-London approximation, molecular orbitals, ortho- and para-hydrogen
Oct. 16	**Midterm Exam**
Oct. 18 – 23	Bravais lattice and reciprocal lattice: primitive vectors, unit cell, diamond structure
Oct. 25 – 28	X-ray diffraction: Bragg formulation, single-crystal and powder scattering
Oct. 30 - Nov. 1	Bloch's theorem: the Born-von Karman boundary condition
Nov. 4 – 6	Electrons in a weak periodic potential:Brillouin zones
Nov. 8 – 15	The tight-binding method: energy bands in graphene
Nov. 18 – 27	Metals, dielectrics, and semiconductors: the band structure, the Drude theory of conductivity, optical properties
Nov. 28 – 29	The Thanksgiving break
Dec.. 2 – 6	Lattice vibrations: Einstein and Debye models
Dec. 12	**Final Exam**