

Course syllabus
Physics 401 -Capstone Course (3 credit hrs.)
Discoveries in Physics
Spring 2015

Instructor: Prof. H.H. Weitering
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Time and place: Room 306 in the Nielsen Physics Bldg.

Meeting times: 2:10-3:25 PM on Tu/Tr

Office hours: Tu/Tr 3:30-5:00 PM or by appointment (ask Mrs. Showni Medlin in the Physics Office)

Course Description and Learning Objectives:

This course is intended for senior physics majors as the capstone experience but it is also open to other students. The central objective of the course is to expose the student to modern physics research beyond the college textbook level and to convey the importance of basic and applied physics research to other science disciplines and the general public. You will learn to synthesize and apply appropriate concepts and methods from thermodynamics, electrodynamics, and quantum theory to selected topics of contemporary physics research. In addition, you will be trained in communicating and articulating the basic principles and broader significance of these topics to a non-expert audience. The latter is an essential component of a physicist's training as he or she will need to find a job, defend research proposals and expenditures to reviewers, funding agencies, politicians, and ultimately the tax payer. The course consists of a series of advanced topic lectures (including guest lectures), discussions, reading assignments, and six oral presentations, all in an informal setting.

Degree level Physics majors will be able to synthesize and apply appropriate concepts
learning objectives: and methods from different areas of physics to selected problems in current physics research.

Outline:**(dates are tentative)**

- Introduction to the course. Reading “More is Different” by P.W. Anderson, and “A Lesson in Humility” by Daniel Kleppner (first week).
- Read Science Magazine’s Breakthroughs of the Year (2014), along with two of your favorite Nobel lectures.
- Bosons, Fermions, and Fermi gases (1/15 – 1/22)
- Hartree, Hartree-Fock, and Density Functional Theory approaches to the many-body problem (1/27 – 2/12)
- Failures of DFT: Mott insulators, Spontaneous symmetry breaking, Emergence (2/17 – 2/24)
- Superconductivity Part I: Phenomenological Theory (2/26 – 3/5)
- Superconductivity Part II: Microscopic Theory (3/10 – 3/12)
- Guest lectures on Chirality, Nuclear Emergence, Plasmons, and the Higgs mechanism (April; Precise dates tbd.)
- Quantized conductance, Quantum Hall Effects, Topological Insulators (4/21 – 4/23)
- Final presentations on the next Nobel prize: 4/28/2014

Each student will give six fifteen minute presentations. Oral presentation dates will be announced two weeks ahead of time.

Prerequisites:

One semester of quantum mechanics (PHYS 411).

Textbook:

There will be hand outs. No textbook required.

Grading:

Based on class participation (60%) and research presentations (40%). There will be no exams.

Attendance policy:

Because your grade will be based on class participation, I expect you to be present. In case you cannot make it, please discuss this with me before class. More than two unexcused absences will lower your course grade by one or several units (e.g. A becomes an A- or B+).

Disability statement:

Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss your specific needs. Please contact the Office of Disability Services at 865-974-6087 in 2227 Dunford Hall to coordinate reasonable accommodations for students with documented disabilities.