University of Maryland
Department of Physics

Spring 2016 Prof. Steven Anlage

Physics 798S

Title:
Physics 798S: Superconductivity: An introduction to the phenomenology and theory of superconductivity. This is a 3 credit course. There are three hours of lecture per week, on average.

Prerequisite:
Phys 623: Graduate quantum mechanics. An undergraduate or (preferably) graduate course in solid-state or condensed matter physics will also be helpful.

Instructor:
Prof. Steven Anlage, Room 1363 (Physics/CNAM). You can find CNAM either by
1) going through the blue door labeled "Center for Nanophysics and Advanced Materials" in the basement of the physics building, or
2) entering from the plaza between the Math and Physics buildings.
Phone: 5-7321, e-mail: anlage@umd.edu.

Schedule:
Two lectures weekly,
Tuesday and Thursday 9:30 to 10:45 AM in Room Z-1219 (Toll Physics building). On average there will be two lectures per week. Some weeks will have only one lecture, others three, but most weeks will have two lectures. Some lectures will be moved to Mondays or Fridays. These will take place in Z-1304 (Toll Physics).

Required Text:
M. Tinkham, *Introduction to Superconductivity*, Second Edition, McGraw-Hill. This book has been republished by Dover ($14.97 at Amazon). ISBN: 978-0486435039.
Other useful books are:
1) James Annett, *Superconductivity, Superfluids and Condensates*, Oxford University Press, 2004 ($40.15 at Amazon). ISBN: 978-0198507567.
2) J. B. Ketterson, S. N Song, *Superconductivity*, Cambridge University Press, New York, 1999 ($115.86 new on Amazon, cheaper used). ISBN: 978-0521565622.
3) J. R. Waldram, *Superconductivity of Metals and Cuprates*, Institute of Physics Publishing, Bristol and Philadelphia, 1996 ($119.95 on Amazon, cheaper used). ISBN: 978-0852743379.
4) Terry P. Orlando and Kevin A. Delin, *Foundations of Applied Superconductivity*, Addison-Wesley, Reading MA, 1991. ISBN: 978-0201183238.

See the class web site for a bibliography of books on superconductivity.

Homework: Homework will be assigned at least every other week. It is imperative that you do the homework and keep up with the material being covered in lecture. I may assign two students to write up solutions to each of the homework assignments. You may work together on the homework assignments, but what you submit for grading should be in your own hand

Class Web Site:
A class web site will announce all homework assignments, and have general class information available. The web site can be found under "Spring 2016" at:
http://www.physics.umd.edu/courses/Phys798S/index.html, or directly at
http://www.physics.umd.edu/courses/Phys798S/AnlageSpring16/index.html.
You can also get to the class web site from my research web site:
http://anlage.umd.edu/AnlageNewTeaching.htm.
Please check the web site periodically.

Office Hours:
Prof. Anlage's office hours are M 2 - 3 PM and W 4 – 5 PM. You are encouraged to attend office hours and discuss the course material, homework, etc.

Final Grade:
Based approximately on homework (~50%), and semester paper on a topic in superconductivity (~50%). Active class and office hour participation (i.e. asking questions!) will improve your chances of obtaining a high letter grade.

Tentative Course Outline:
1) Introduction – Basic phenomena, perfect conductivity, perfect diamagnetism, critical temperature, fields, and currents, type-I and type-II, high-temperature superconductors, applications.
2) Simplest theory: perfect conductivity, the London equations, and the macroscopic quantum model.
3) Microscopic theory: Second quantization and BCS theory. Cooper pairing instability, quasiparticles, the energy gap.
4) Ginzburg-Landau (GL) theory: general Landau and GL theories, application to superconductors.

5) GL theory and type-II superconductors (conventional and high-temperature.) Critical currents and fields, vortices, vortex interactions, the structure of an isolated vortex.
6) Fluctuation effects in low and high-T_c superconductors: GL theory, Kosterlitz-Thouless transition, scaling, vortex phase transitions, Andreev scattering.
7) Josephson effect: Basic equations, shunted junction models, SQUIDs.