Instructor: Steve Johnston  
Office location: 406-A Nielsen Physics Building  
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Class Time: Tuesday & Thursday, 12:40-1:50 pm  
Classroom: Nielsen Physics Building 512  

Overview  
This course will build upon the material covered in Phys. 671. The aim is to provide you with the tools and framework for understanding of advanced topics in solid state physics and materials research.  

Prerequisites  
This course assumes you have taken a graduate level course in solid-state physics (Phys. 671). I assume you have been exposed to the concepts of the bravais lattice, the free electron model, electrons in a periodic potential, the band theory of solids, classical models for lattice vibrations, and quantum mechanics.  

Office Hours  
I will hold drop in office hours on Monday from 10-12 am. Other times can be arranged by email appointment. You can also raise any issues or questions you have regarding the course material immediately after lectures.  

Topics  
1. Introduction to second quantization with examples: the H₂ molecule and the uniform electron gas.  
2. Magnetism and Magnetic Order: exchange interactions, the Heisenberg model, magnetic ordering, ferromagnetic and antiferromagnetic magnons & spin wave theory.  
5. Semiclassical model of electron dynamics and transport.  
6. Beyond bandstructure: revisiting H₂, the Hubbard model, Mott and charge-transfer insulators.  
8. The copper problem, conventional and unconventional superconductivity.  
9. (If time permits) Impurities: resistivity in alloys, the Anderson impurity model, the Kondo problem.
Grading & evaluation
Assignments 40%
Mid-term Exam 20%
Final Exam 40%

Problem sets will be handed at regular intervals. I encourage you to discuss these problems amongst yourselves, however you are expected to turn in your own work. Homework will be due at the beginning of class on the day on which it is due. Once I begin the lecture, the assignment is late. The assignment portion of your grade will be marked as a sum total; I will total your points and divide by the total number of available points across all assignments.

The mid-term exam will be in-class. I will not ask you to solve difficult problems and will mostly focus on conceptual questions and definitions. You will also be asked to solve some simple problems at this point, likely drawn from the class examples and the homework assignments to date.

The final exam will be compressive and divided into two components. The first will be an in-class component similar to the mid-term. I will ask you to solve some basic problems without the aid of your textbook and your understanding of basic definitions and concepts. The second component will be an extended take home exam where I will ask you to solve a number of problems. You will be allowed to use reference material, however you are expected to work independently and cite any material you draw upon.

Late policy
No extensions will be given on material without a note from a medical doctor or prior arrangements with me. If you think you will have to hand in an assignment or the final exam late, please see me as far in advance of the due date as possible. Without prior arrangements or extenuating circumstances, I will reduce the grades as follows: 75% of the maximum grade on day one, 50% of the maximum grade on day two, and 0% of the maximum grade on day three. A day will be counted as a 24-hour period from the beginning of lecture the day the assignment was due. The final exam must be handed in on time. A mark of 0 will be assigned if it is late without prior arrangement with me.

Textbook and other reference material
I will be drawing heavily from Quantum Theory of Solids by Charles Kittel, which is why this book was assigned. I will also draw material from other books and handout material as appropriate. You can also find relevant discussion of many of these subjects in Prof. Quinn’s lecture notes from the previous term.

I recognize that students may find other books more suited to their learning style. I also recommend the following books if you find Kittel insufficient.

1. Magnetism in Condensed Matter, Blundell.
5. *Many Particle Physics*, Mahan. (Very advanced, may not be suitable for this course but highly recommended if you plan on pursuing research in this field.)

For students with disabilities
Any student who feels they may need an accommodation based on the impact of disability should contact me privately to discuss specific needs. I will contact the Office of Disability Services at 865-974-6087 in Hoskins Library to coordinate reasonable accommodations for students with documented disabilities.

Plagiarism and Cheating
Cheating will not be tolerated. Everyone must have an equal chance to do well. The penalty for cheating on any aspect of this course will be an “F” for the course. This includes writing on your exam after I have announced it is ended, or any other unfair advantage taken over other students. No outside materials are permitted on the in-class components of the exams, except those provided by the instructor.

Plagiarism of any kind will not be tolerated. Working together on homework does not count as plagiarism however, a line-by-line copy of another student’s homework does. If you use a source (book, articles, internet material etc.), you must cite it. The use of a source without citation is plagiarism.

Cheating and/or plagiarism cases found to be in Violation of the Academic Honesty policies will result in disciplinary actions according to the University rules, without exception.