

## SYLLABUS: PHZ 7427, **Physics of Solids II**

Spring 2023

Instructor: Peter Hirschfeld, NPB 2156, interests in superconductivity and strongly interacting electronic systems.

Office Hours : M 3pm, W 3pm; or just drop in—I will try to make time to discuss if I am free.

Course description: Meets 1:55pm MWF in NPB 1101. See course web page for announcements of exceptions. Topics: physics of collective phenomena in condensed matter systems: electron-electron and electron-phonon interactions, superconductivity, magnetism and quantum transport.

Prerequisites: PHZ6426 or equivalent course covering fundamentals of 1-electron theory of solids.

Recommended Texts: None

Supplementary Texts

- C. Kittel, *Quantum Theory of Solids*, New York: John Wiley 1987
- N. Ashcroft and N.D. Mermin, *Solid State Physics*, Philadelphia:Saunders College, 1976.
- G. Mahan, *Condensed Matter in a Nutshell*, Princeton: Princeton U. Press, 2011.
- P. Phillips, *Advanced Solid State Physics*, Boulder: Westview Press, 2003.
- S. Blundell, *Magnetism in Condensed Matter*, New York: Oxford, 2001.
- N. H. March and W. Jones, *Theoretical Solid State Physics*, New York: Wiley, 1973 (Dover Paperbacks!)
- A.A. Abrikosov, *Fundamentals of the Theory of Metals*, New York: Elsevier, 1988
- J.M. Ziman, *Principles of the Theory of Solids*, Second edition (Cambridge University Press, 1972)
- O. Madelung, *Introduction to Solid-State Theory*, (Springer-Verlag, 1978).
- M. Tinkham, *Introduction to Superconductivity*, Third edition, (Dover, 2004).
- P. Misra, *Physics of Condensed Matter*, San Diego: Academic Press 2012.

Required Work: ~6 Problem Sets (40%), Midterm (20%), Final (25%), 1 30-min Journal club presentation (15%).

Week(s)	Topic(s)	Read (notes +...)	Homework	Remarks
Jan. 8	<i>I. Second Quantization</i> 1. Free Fermi gas 2. Phonons	Misra pp. 53-60, Kittel Ch. 2, AM Chs. 2-4,22-24	Prob. Set 1	PH travel 1/8-18 (Chennai, India). Zoom.
Jan. 23 Jan. 30	<i>II. Electron-electron interactions</i> 1. Screening in electron gas 2. Plasma oscillations 3. Fermi liquid theory 4. Failures of band theory	Misra Ch. 7, Kittel Ch. 3, AM Ch. 17	Prob. Set 2	1/16 MLK Day 1/18-no class
Feb. 6 Feb. 13 Feb. 20	<i>III. Magnetism</i> 1. Para/diamagnetism of single ions 2. Origin of magnetic exchange 3. Magnetic ordering 4. Magnons in ferro- and antiferromagnets 5. Magnetic neutron scattering 6. Itinerant magnetism/ Hubbard model 7. Kondo problem	Misra Chs. 12-13, AM Chs. 31-33, Kittel Ch. 4	Prob. Set 3	Jclub topics due
Feb. 27	<i>IV. Electron-phonon interactions</i> 1. Coulomb screening of ionic plasmon 2. Resistivity of metals/ Umklapp 3. Effective electron-electron interaction	Misra Sec. 8.11, AM Ch. 26, Kittel Ch. 7	Prob. Set 4	Midterm 2/27 (in-class) PH Travel Mar. 1-3 (UCLA,Riverside)
Mar. 13 Mar. 20 Mar. 27	<i>V. Superconductivity</i> 1. Phenomenology/ London theory 2. BCS theory 3. Ginzburg-Landau theory 4. Magnetic properties 5. Josephson effect	Ch. 14, Kittel Ch. 8. AM Ch. 34	Prob. Set 5	APS Mtg. Mar. 5-10. Class cancelled. S. Brk. 3/11-18.
Apr. 3 Apr. 10 Apr. 17	<i>VI. Topological States in CM</i> 1. Topo. insulators 2. Edge states 3. Topo superconductors	Qi-Zhang RMP 83, 1057.	Prob. Set 6	PH travel (LSU,Rice) Apr. 17-20.
Apr. 23	<i>Jclub, Final exam</i>	All	None	Take-home.

### 1. **Web page**

Course announcements, schedule, homework & solutions, as well as reviews of lectures and this syllabus in its entirety will be posted at [http://www.phys.ufl.edu/~pjh/teaching/phz7427/7427\\_S23\\_index.html](http://www.phys.ufl.edu/~pjh/teaching/phz7427/7427_S23_index.html). E-learning (Canvas) will be used only to post grades.

### 2. **Disabilities (Accommodations)**

Students who will require a classroom accommodation for a disability must contact the Dean of Students Office and request proper documentation. Upon bringing that documentation to the Instructor, the student will be given the appropriate accommodations. No accommodations are available to students who lack this documentation.

It is the policy of the University of Florida that the student, not the instructor, is responsible for arranging accommodations when needed. The instructor will not remind the student to schedule accommodations prior to each quiz or exam. If you require extra time for in-class work, you must initiate this request at least seven days before the exam or quiz.

### 3. **Academic Honesty**

All students are required to abide by the principles of academic honesty expressed in the Student Honor Code. Consistent with university policy, any incident of academic dishonesty in this course will be reported to the Dean of Students Office. It is normal and reasonable for students in this physics course to work together on homework assignments, but certain other activities are unacceptable: academic dishonesty includes plagiarism, fabricating information, giving or receiving any unauthorized assistance on academic work, and interfering with the academic work of other students. Submitting homework solutions that were simply copied or transcribed from another student, a book, or a website is clearly dishonesty, because it is not your own work. Supplying a false or fabricated excuse for missed academic work is also academic dishonesty. If the incident is the student's first offense at UF, the student will receive a failing grade in PHY4324. If not, the Dean of Students Office will decide the appropriate sanction.

Students sometimes ask why such an emphasis is placed on plagiarism, etc. In the view of the instructor this is a professional rather than a moral issue. As faculty, we are trying to train students to create and discover new knowledge. An attitude which allows the recycling of old knowledge is clearly detrimental to such a goal. We therefore create academic structures to discourage such recycling and encourage you to think for yourselves.

The Dean of Students Office website has further details on academic honesty policies at UF. In particular, those of you planning to write term papers please visit <http://web.uflib.ufl.edu/msl/07b/studentplagiarism.html>.

### 4. **Diversity**

Physics is practiced and advanced by a scientific community of individuals with diverse backgrounds and identities and is open and welcoming to everyone. The professor recognizes the value in diversity, equity and inclusion in all aspects of this course. This includes, but is not limited to differences in race, ethnicity, gender identity, gender expression, sexual orientation, age, socioeconomic status, religion and disability. With this in mind, it is expected that all students behave towards other students in the class with respect in all situations.

### 5. **Religious Holidays**

Major religious observances will be accommodated. It is university policy, however, that the student must inform the instructor of religious observances that will conflict with class attendance or other activities, prior to the class or the occurrence of that activity. Since major religious holidays are generally known well in advance, the instructor expects the student to provide at least 7-10 days of advance notice of any upcoming religious observance.