Phys 625 **Solid State Physics I** **SPRING - 2006**

- **Instructor: Dr. Igor Ostrovskii**

➢ **Course objectives:**

1. Introduce the physics major graduate students to Solid State Physics.
2. Advance an understanding of the ideas of quantum physics applications to solid state/condensed matter.
3. Expand an awareness of the current basis of knowledge in physics including crystal structure, crystal binding, electrons and phonons in crystals, semiconductors, and basic properties of solids.
4. Discuss the problems confronting physics of solids in the 21-st century.

❖ **Lecture:** T,Th 9:30 – 10:45, Room 126 Lewis Hall
❖ Office: Room 207 Lewis Hall, Email: iostrov@phy.olemiss.edu
❖ **Office Hours: M,W,Th 2:30 – 3:30 p.m. (207 Lewis Hall)**

TEXTS

Main reading:

1)"Introduction To Solid State Physics" by Charles **Kittel**, 8-th edition, 2005.

Additional reading:

2) "Condensed Matter Physics" by Michael P. **Marder**, John Wiley & Sons, 2000.

- Grading Scale: A ---------- 90 – 100,
  B ---------- 80 – 89,
  C ---------- 70 – 79, etc.

Grades will be based on the home works, chapter tests, and final examination:

Home works ---------- 15%
Three tests ---------- 45% (#1=15%, #2=15%, #3=15%)
Final examination ---------- 40%
TOTAL = ----------100.

➢ **Chapter Tests and Final examination schedule:**

➢ **Test 1 (**Crystal structure and binding, Phonons in Solids**): Tuesday, February 21.**
Chapters 1, 2, 3, 4, 5.
➢ **Test 2 (**Electrons and Energy bands, Semiconductors**): Tuesday, April 4.**
Chapters 6, 7, 8.
➢ **Test 3 (**Optical processes, Dielectrics and Ferroelectrics, Crystal Defects**): Tuesday, May 2.**
Chapters 15, 16, 20.

❖ **FINAL EXAMINATION ---------- Thursday, May 11, 4 p.m.**

- Homework Rules:

1. Homework is assigned after some sections are covered and is due in a week.
2. Homework paper should be 8.5 x 11 inches with no torn or tattered edges. Homework papers should be stapled.
3. Show all your work; the answer alone is not worth anything. Homework problems must include enough English to be understandable.
4. **Important**: **Circle the finale answers that you want to be graded**.

SYLLABUS

1. CRYSTAL STRUCTURE [Ch. 1**].**
Fundamental types of crystal lattices. Simple crystal structures.

2. WAVE DIFFRACTION AND THE RECIPROCAL LATTICE [Ch.2].
Diffraction of X-rays and matter waves by crystals. Brillouin Zones.

3. CRYSTAL BINDING [Ch. 3].
Binding in the crystals of inert gases, ionic crystals, covalent crystals, metals. Hydrogen bonds.

4. PHONONS I: CRYSTAL VIBRATIONS [Ch.4**]**.
Vibrations of crystals with monatomic basis. Two atoms per primitive basis.
Quantization of elastic waves. Phonon momentum. Inelastic scattering by phonons.

5. PHONONS II: THERMAL PROPERTIES [Ch.5**].**
Phonon heat capacity. Anharmonic crystal interactions. Thermal conductivity.

- **TEST #1 (Class 11) → Tuesday, February 21**

6. FREE ELECTRON FERMI GAS [Ch.6**].**
Energy levels in one dimension. Effect of temperature on the Fermi-Dirac distribution.
Free electron gas in three dimensions. Heat capacity of the electron gas. Electrical conductivity and Ohm's law. Hall Effect. Thermal conductivity of metals.

7. ENERGY BANDS [Ch. 7**].**
Nearly free electron model. Bloch functions. Kronig-Penney Model. Wave equation of electron in a periodic potential. Number of orbitals in a band.

8. SEMICONDUCTOR CRYSTALS [Ch. 8**].**
Band gap. Equations of motion. Intrinsic carrier concentration. Impurity conductivity.
Thermoelectric Effects. Semimetals. Superlattices.

- **TEST #2 (Class 21) → Tuesday, April 4**

9. OPTICAL PROCESSES AND EXCITONS [Ch. 15**].**
Optical reflectance. Excitons. Raman Effects in crystals.
Energy loss of fast particles in a solid.

10. DIELECTRICS AND FERROELECTRICS [Ch. 16].
Macroscopic electric field. Dielectric constant and polarizability. Structural phase transitions.
Ferroelectric crystals. Ferroelectric domains. Piezoelectricity.

11. POINT DEFECTS IN SOLIDS [Ch. 20**].**
Lattice vacancies, Diffusion, Color centers.

- **TEST #3 (Class 29) → Tuesday, May 2**

12. REVIEW **[**LAST CLASS]

- **FINAL EXAMINATION ---------- Thursday, May 11, 4 p.m.**

* - The dates of three tests are tentative, and may be changed.