

UNIVERSITY OF CALGARY
DEPARTMENT OF PHYSICS and ASTRONOMY
COURSE OUTLINE

1. Course: **Physics 507, Solid State Physics**

Lecture/Time/Session(s): L01; MWF, 13:00-13:50, ST 061, Winter 2011

Instructor(s): Dr. D.L. Feder

Office: SB 535, 220-3638

Office Hours: M, 14:00-16:00

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Course website: <http://people.ucalgary.ca/~dfeder/507>

2. Prerequisite(s): Physics 443 or Chemistry 373; Physics 449; Physics 455.

3. **GRADING:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Weekly Previews	10%
Assignments	40%
Midterm Examination	25%
Final Examination	25%

A table of conversion from final course percentage to final course letter grade can be found on the Phys 451 site.

There will be a final examination scheduled by the Registrar's Office. A passing grade on the final examination is required in order to pass the course.

4. **Missed Components of Term Work.** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in section 3.6: <http://www.ucalgary.ca/pubs/calendar/current/sc-3-6.html>. It is the student's responsibility to familiarize himself/herself with these regulations. See also <http://www.ucalgary.ca/pubs/calendar/current/e-3.html>.

5. **TEXTBOOK:** "*Quantum Theory of Solids*," by Eoin O'Reilly (Taylor and Francis, 2002). Other suggestions for textbooks can be found on the course website.

6. **EXAMINATION POLICY:** Students are encouraged to read the Calendar, Section G, on Examinations: <http://www.ucalgary.ca/pubs/calendar/current/g.html>

Department Approval _____ Date _____

Associate Dean's Approval for
out of regular class-time activity: _____ Date: _____

7. OTHER IMPORTANT INFORMATION FOR STUDENTS:

- (a) **ACADEMIC MISCONDUCT** (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under K. Student Misconduct (<http://www.ucalgary.ca/pubs/calendar/current/k.html>) to inform yourself of definitions, processes and penalties
- (b) **ASSEMBLY POINTS in case of emergency during class time.** Be sure to **FAMILIARIZE YOURSELF** with the information at <http://www.ucalgary.ca/emergencyplan/assemblypoints>.
- (c) **ACADEMIC ACCOMMODATION POLICY.** Students with documentable disabilities are referred to the following links:
Calendar entry on students with disabilities: <http://www.ucalgary.ca/pubs/calendar/current/b-1.html>
Disability Resource Centre: <http://www.ucalgary.ca/drc/>
- (d) **SAFEWALK:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call **220-5333** for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.
- (e) **FREEDOM OF INFORMATION AND PRIVACY:** This course will be conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, **students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page.** For more information see also <http://www.ucalgary.ca/secretariat/privacy>.
- (f) **STUDENT UNION INFORMATION:** VP Academic **Phone:** 220-3911 **Email:** suypaca@ucalgary.ca.
SU Faculty Rep. **Phone:** 220-3913 **Email:** sciencerep@su.ucalgary.ca Website <http://www.su.ucalgary.ca/home/contact.html>.
Student Ombudsman: <http://www.su.ucalgary.ca/services/student-services/student-rights.html>
- (i) **INTERNET and ELECTRONIC COMMUNICATION DEVICE Information.** You can assume that in all classes that you attend, **your cell phone should be turned off.** Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

Breakdown of the Material

1. Review of Quantum Mechanics

- (a) Bohr-Sommerfeld quantization: particle in a box
- (b) Stationary-state Schrodinger's equation: particle in a box
- (c) Momentum space
- (d) Variational principle
- (e) Density of States
- (f) Fermi energy
- (g) Finite square well

2. Bonding in Molecules and Solids

- (a) Double square-well
- (b) Degenerate perturbation theory
- (c) Double harmonic oscillator
- (d) The H₂ molecule
- (e) Semiconductor molecules (Si, GaAs, etc.)
- (f) Bravais and non-Bravais lattices, symmetries

3. Band Structure

- (a) Bloch's theorem, reciprocal space, Brillouin zones.
- (b) Band structure
- (c) Weak-binding limit: Kronig-Penney model
- (d) Strong-binding limit: Tight-binding model
- (e) Pseudopotential methods
- (f) Particles, holes, and effective mass
- (g) Bloch and de Haas van Alphen oscillations

Midterm Examination

Course Outline

Breakdown of the Material, cont'd

4. Beyond the independent electron model

- (a) Hartree equations
- (b) Hartree-Fock equations and correlations
- (c) Screening
- (d) Fermi Liquid Theory

5. Optical Properties

- (a) Electron gas as a plasma
- (b) Reflectance: opacity and color
- (c) Refraction and birefringence
- (d) Kerr effect
- (e) Metamaterials: cloaking devices

6. Semiconductors

- (a) Valence and conduction bands
- (b) Quantum wells, quantum wires, quantum dots
- (c) p-n junctions
- (d) Semiconductor heterojunctions
- (e) classical Hall effect
- (f) Integer quantum Hall effect
- (g) Fractional quantum Hall effect
- (h) Semiconductor lasers

Final Examination (2nd half only)