Condensed Matter Physics

PHYS-4160 & PHYS-8160 (Fall 2021)

Instructor:

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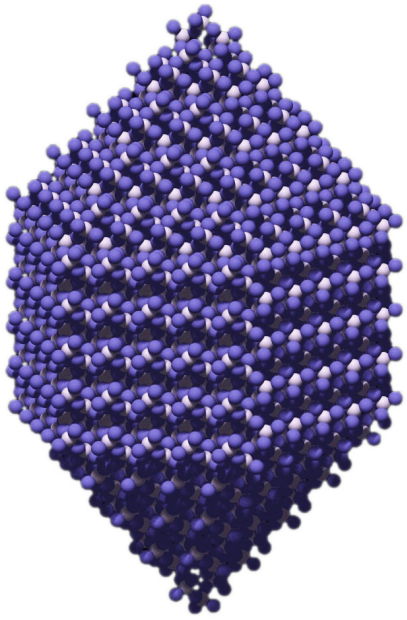

Office hours:

Days:	Tuesday and Thursday
Time:	11:30AM - 12:30PM or by appointment
Location:	Essex Hall 289-1

Lectures:

Days:	Tuesday and Thursday
Time:	10:00AM - 11:30AM
Location:	Essex Hall 287

Assessment:

45%	Assignments	(~ Weekly, lowest two grades dropped)
25%	Mid-term exam	(Thursday October 28th, 2021)
30%	Final exam	(Cumulative, TBD)

Materials:

Recommended text:	*The Oxford Solid State Basics*, S. H. Simon	ISBN: 0199680779
Useful resources:	*Introduction to Solid State Physics*, C. Kittel	ISBN: 047141526X
	Solid State Physics, N. Ashcroft & N. D. Mermin	ISBN: 0357670817
	Quantum Theory of Solids, C. Kittel	ISBN: 0471624128

Course information:

Website:	Blackboard (e.g. notes, discussions, assignments)
Prerequisites:	PHYS-3100 or PHYS-3105 or consent of instructor
Description:	Elements of crystallography, crystal diffraction, reciprocal lattices, lattice dynamics and thermal properties of solids, phonons, solution of Schroedinger equation in periodic potential, band theory, Fermi surfaces of metals and semiconductors, optical properties of dielectrics.

Course Outline

A (tentative) course outline is given below, with corresponding chapters of *The Oxford Solid State Basics* by S. H. Simon indicated. The content of the course is, in the end, determined by what is covered in the lectures.

Overview [Chapter 1]

- What is *condensed matter physics*?
- What are the questions we are trying to answer?

Crystal geometry [Chapter 7, 12-14]

- Phases of matter
- Bravis lattices and unit cells; Miller indices; Crystal symmetry
- Reciprocal space and the Brillouin zone
- Diffraction
  - X-ray and neutron scattering experiments
  - Bragg and Laue conditions, scattering amplitudes

Phonons in crystals [Chapter 2, 8-10]

- Sound and elasticity
- Linearized vibrations of periodic lattices
  - Optical and acoustic modes
- Phonons and Bose statistics
  - Dulong-Petit Law
  - Einstein and Debye models
- Thermodynamics, thermal transport

Electrons in crystals [Chapter 3-4, 11, 15-16]

- Metals, insulators, semi-metals, semi-conductors
- Drude Model
  - Thermodynamics
  - Charge and thermal transport, Hall effect
- Nearly free electron model and Fermi statistics
  - Fermi sea, Fermi surfaces
  - Bloch's theorem
  - Weak periodic potential; Band Structure
- Nearly atomic electron model, tight-binding method

Lectures

The main delivery method for the course material will be through sets of **in person lectures** during our scheduled lecture times.

- There will be **two 80 minute sessions per week**, held during our scheduled class period (10:00AM-11:30PM, Tuesday and Thursday) in Essex Hall room 287.
- Students will be expected to follow all university policies with regard to mask wearing, vaccination, distancing and any other public health measures while on campus.

Assignments

Assignments are to be done as homework will be given (approximately) every week. Deadlines will be typically be one week after the assignment is posted (the precise date and time will be listed on the assignment). **The lowest two assignment grades will be dropped.**

- Homework must be prepared in a professional and legible manner and must be turned in either as a *hard-copy* or *electronically* through Blackboard. If handwritten, the pages must be scanned and uploaded as a *single* PDF file. If prepared electronically, the final output format must be PDF.
- Feedback will be provided electronically to electronic submission, and a marked PDF will be returned via Blackboard as an attachment in the “Feedback to Learner" section. For hard copies feedback will be on the assignment and it will be returned in class.
- **No late homework will be accepted** – after the deadline it will be given a mark of zero.
- While discussing the problems with your peers is encouraged, homework is to be written and submitted *individually* and should represent *your own work*.
- Copying from other students or from *any other source* is *not allowed* (this includes websites and discussion boards). Plagiarism and academic dishonesty are serious offences and will be addressed using university guidelines and policies. If necessary, each student will be responsible for defending their homework solutions.

Mid-term exam

The mid-term exam will be written **in person** during our scheduled lecture time. It will be a conventional closed book and closed notes exam.

- *Date*: **Thursday October 28th, 2021**
- The material covered will be from the start of the course up to the previous week.
- Exams will consist primarily of worked problems, similar to (but not identical to) the problems that have been assigned for the homework. A short-answer portion covering more conceptual questions may also be included at my discretion.
- There will be *no make up exam* for the mid-term. If the mid-exam is missed, with acceptable medical (or equivalent compassionate) reasons, the weight of that exam will be transferred to the final exam, with the assignments reweighted to 50% of the course grade and the final exam to the remaining 50%.

Final exam

The final exam will be a three-hour written comprehensive exam drawn from *all* of the course, at similar level to the mid-terms and homework. The exam will take place over *three hours* on our scheduled exam day. The exam will be a conventional closed notes/book exam.

- *Date:* **To be determined** (Final exam period: December 11th - 22nd, 2021)
- If your grade on the final exam is higher than your mid-term exam grade, the final exam grade will replace it.
- A make-up examination for the final exam will only be administered with acceptable and verifiable medical (or equivalent compassionate) reasons, handled through the official University of Windsor channels and procedures.

Technical

- All email correspondence must be from your University of Windsor email address; email from other addresses will be ignored. Please include the course number (PHYS-4160 or PHYS-8160) in the subject line any emails so I can get to it quickly.
- If you have a conflict with the posted office hours, you are also free to ask me questions at any time via email (though I will not guarantee a response rate, I will try my best). Alternatively, you can also arrange a scheduled time for a one on one (in person or virtual) discussion.
- Files submitted electronically should have a filename that indicates the course number (PHYS-4160 or PHYS-8160), what is being submitted and your full name.
- If there are technical difficulties in (e.g.) submitting an assignment through Blackboard, you may email it directly to me (from your offical University email account).
- For scanning of hand-written pages there are many good smartphone applications that directly produce PDFs. Some examples include Office Lens (Android, iOS) and Adobe Scan (Android, iOS).

Miscellaneous

- *Voluntary withdrawal deadline*: **December 6th, 2021**
- *Reading week:* **October 9th, 2021 - October 17th, 2021**
- For a medical absences the requirement to submit medical notes for the Fall 2021 semester has been waived, and students should use the self-report of illness interface.
- As per senate rules, grades are percentages, reported as whole numbers.
- The content of the course is, in the end, determined by what is covered in the lectures and not by the outline provided in the syllabus.
- The Student Evaluation of Teaching (SET) forms will be completed online through UWinsite Student in the final two weeks of the semester. Instructions are available here.
- Students in need of university-recognized accommodations (via student accessibility services) should make themselves known to the instructor at the beginning of the course and discuss what arrangements are needed and how they might be accommodated.

- University of Windsor's student code of conduct provides that all students are expected to commit to a code of behavior based on dignity and individuality, and respect for the rights and property of others.
  - Anyone exhibiting disruptive behavior during synchronous sessions will be asked to leave. Disciplinary actions will be taken for failure to follow directions.
  - Plagiarism and academic dishonesty are serious offences and will be addressed using university guidelines and policies.
- For help addressing mental or physical health concerns, refer to the wellness outreach office for a full list of on-and off-campus resources available to students.

Addtional requirements for PHYS-8160

Graduate students taking this course for graduate credit have additional assessments that must be completed.

- Assignments will contain an additional, more challenging question. While undergraduate students may attempt this questions as a bonus, for graduate students this **must be completed** and is *not a bonus*, counting as a regular question towards the assignment grade.
- Graduate students **must prepare final report on an advanced topic in condensed matter physics**. The topic is to be chosen in consultation and with the approval of the instructor. The report will be worth 15% of the grade, reducing the homework, mid-term and final exam weights by 5% each. Length should be 5-10 pages (single-spaced), depending on the specific topic chosen and what can be meaningfully covered in the report (details to be determined through discussion with the instructor).
- *Final report due date*: **November 30th, 2021**