Chemistry 3364B Course Outline

1. Course Information

Course name: Chemistry 3364B, ***Physical Chemistry of Materials*** (Winter 2024/2025)

Lectures: [redacted]

Location: [redacted]

Lab: No lab

Prerequisite: Chemistry 2214A/B, Chemistry 2274A or the former Chemistry 2384B

Unless you have either the requisites for this course or written special permission from your Dean's Designate (Department/Program Counsellors and Science Academic Counselling) to enroll in it, you may be removed from this course, and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees if you are dropped from a course for failing to have the necessary prerequisites.

2. Instructor Information

Instructors	Email	Office	Phone	Office Hours
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Students must use their Western (@uwo.ca) email addresses when contacting their instructors.

Office hour: to be announced in class.

3. Course Syllabus, Schedule, Delivery Mode

Academic Calendar Course Description: An introduction to the structure, bonding, properties, and functionalities of materials, fabrication, and characterization technique as well as applications in modern science and technology.

Learning outcome: At the end of the course, the student will be able to

- Understand the structure, bonding and their relationship to the properties of the materials and the jargons used in different fields of materials sciences

- Understand how these materials are made and their functionality in a device
- Evaluate the requirements for materials to be used in a specific application and perform selection of materials with required properties
- Select the most appropriate analytical techniques for testing the properties of materials in specific applications.

1. **Detailed List of Topics: Introduction. Classification of Materials.**
   1.1. Metals and Alloys
   1.2. Semiconductors
   1.3. Polymers
   1.4. Molecular Functional Materials, Thin Films and Nanostructures.
2. **Structure of Materials**
   2.1. Introduction to Lattices
      2.1.1. Translation Vectors and Unit Cells
      2.1.2. Lattice Axes, Planes and Directions. Miller Indices, Reciprocal Lattice
   2.2. Bonding in Solids
      2.2.1. Bonding in Elemental Solids (Covalent, Metallic, Van-der-Waals bonding)
      2.2.2. Bonding in Multi-element Solids (Ionic, Ionic-Covalent, Hydrogen Bonding).
      2.2.3. Bonding in Molecular Solids. π-Conjugation and π-Stacking.
   2.3. Surface Phenomena. Nucleation. New Phases and Particular Materials
3. **Properties of Materials**
   3.1. Electrons in Solid State
      3.1.1. Band Structure. Metals, Semiconductors and Insulators.
      3.1.2. Fermi Energy and Work Functions. Contact Potential Differences.
      3.1.3. Dielectric Constants. Debye Length.
   3.2. Surface Phenomena. Nucleation. New Phases and Particular Materials
4. **Making Materials**
   4.1. Metals and Alloys: Introduction
   4.2. Phase diagram
   4.3. Vaper-Liquid Solid techniques, nanomaterials
5. **Introduction into Experimental Techniques for the Characterization of Materials**
   5.1. Diffraction. Bragg's Law. X-Ray Diffraction.
   5.2. Interaction of Electrons with Matter. Elastic and Inelastic Scattering. Inelastic Mean Free Path.
   5.3. Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).
   5.4. Electron Back Scatter Diffraction (EBSD.
   5.5. X-ray techniques: X-ray Photoelectron Spectroscopy (XPS) and X-ray Fluorescence (XRF). Auger Electron Spectroscopy (AES). Energy Dispersive (EDX) X-ray Fluorescence Analysis. Ultraviolet Photoelectron Spectroscopy (UPS).

Important Dates

Classes begin: September January 6, 2025
Winter Reading Week: February 17 – 21, 2025
Classes end: April 4, 2025
Exam period: April 7 – 30, 2025

Contingency plan
Although the intent is for this course to be delivered in person, should any university-declared emergency require some or all the course to be delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will **not** change. Any assessments affected will be conducted online as determined by the course instructor.

4. Course Materials

Recommended texts – useful but <u>not</u> required:

- *Bradley D. Fahlman, Materials Chemistry, Springer; 2nd edition 2011*
- *Joel I. Gersten and Frederick W. Smith, The Physics and Chemistry of Materials, Wiley-Interscience; 1st edition (June 25, 2001).*
- *Nils Petersen, Chemistry of Materials, CRC Press 2017*

Online Resources: Notes and assignments will be available online through OWL Brightspace in pdf format. You must print these notes, or you can save them to a laptop/tablet where you can annotate them. The lecture notes are power point slides. They will be posted on OWL prior to class as appropriate.

Use of electronic devices. Only basic scientific calculators are permitted on tests and exams. All other electronic devices (cell phones, laptops, tablets, cameras, etc.) are prohibited. Students found in possession of prohibited devices will receive a mark of ZERO for the entire test or exam.

Students are responsible for checking the course OWL site (http://owl.uwo.ca) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class.

All course material will be posted to OWL: http://owl.uwo.ca.

If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

5. Methods of Evaluation

Assignments	(approximately 4 in total)	20%
Midterm 1	Friday, February 7, in-class	20%
Midterm 2	Friday, March 7, in-class	20%
Final Exam	(date and time will be set by the Registrar)	40%

6. Student Absences

Missed Labs/Assignments: You are allowed to miss one assignment without an excuse and without penalty. For students that complete all assignments, the assignment with the lowest mark will be dropped. If you miss more than one assignment, please contact the Academic Advising Office to request academic consideration. If academic consideration is granted, the weight of the missed assignment will be redistributed among the other assignments. *There will be no make-up assignments*.

Regardless of circumstances, if you miss more than half of the assignments, *you will receive a course grade of not greater than 40%, even if the calculated grade is higher. For students with valid excuses, the only remedy against an F in such cases would be to apply for an INC grade through the Dean's Office and complete the missed work the next time the course is offered.*

Missed Midterm: If you miss a midterm test, you must apply for academic consideration through the Academic Advising Office. If approved, the weight of the missed midterm will be transferred to the final exam. *There will be no make-up midterm tests.*

Absences from Final Examinations

If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you can do so. They will assess your eligibility to write the Special Examination (the name given by the University to a makeup Final Exam).

You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See the Academic Calendar for details (under Special Examinations).

7. Accommodation and Accessibility

Religious Accommodation
When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at

https://multiculturalcalendar.com/ecal/index.php?s=c-univwo.

Accommodation Policies
Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf.

8. Academic Policies

The website for Registration Services is http://www.registrar.uwo.ca.

In accordance with policy,

https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf,

the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

Electronic calculators will be permitted on tests and exams.

Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

9. Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.uwo.ca/sci/counselling/.

Students who are in emotional/mental distress should refer to Mental Health@Western (https://uwo.ca/health/) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.