

Subject ES2206A Course Outline – Fall 2026

1. Course Information

Course Information:

Earth Science 2206A Mineral Systems, Crystallography, and Optics (Fall 2026)

Lectures: Monday and Wednesday: 9:30 am to – 10:20 am ((location undisclosed)

Laboratory: Tuesday: 6:00 pm – 9:00 pm or Wednesday: 2:30 pm – 5:30 pm (location undisclosed)

List of Prerequisites:

Pre-or Corequisite(s): Earth Sciences 1022A/B or Earth Sciences 2200A/B or permission of the Department.

Unless you have either the prerequisites for this course or written special permission from the instructor to enroll in it, you may be removed and withdrawn from this course in accordance with university policy. This may be done after the add/drop deadline of the academic term, and the course will be marked as withdrawn (WDN) on your academic record. This decision may not be appealed.

2. Instructor Information

Instructors	Email	Office	Phone	Office Hours
Dr. Roberta Flemming (Course Coordinator)	rflemmin@uwo.ca	BGS-0172	519-661-3143	By appointment
Kyran Punch (TA)	kpunch@uwo.ca			By appointment
Yarden Gedalia (TA)	ygedalia@uwo.ca			By appointment

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

3. Course Syllabus, Schedule, Delivery Mode

Objectives: This course introduces students to minerals. We will examine their crystalline nature, chemical composition, physical and optical properties. Students will also develop an understanding of the connections between these phenomena. From a theoretical perspective, students will understand how the properties of minerals are a product of their crystalline nature and how mineral structures can be understood systematically. Practical laboratories will strengthen students' understanding of the above concepts; students will become proficient at identifying minerals using physical and optical properties.

Learning Outcomes:

Upon successful completion of the course the student will be able to:

1. Classify crystals into six crystal systems based on symmetry, name crystal forms, & assign Miller indices.
2. Identify minerals in hand sample by their physical properties through mineral quizzes and a Lab exam.
3. Identify minerals by their optical properties using a polarizing microscope and recognize their formation environments (igneous or metamorphic) using mineral textures and associations.
4. Predict cation substitution in mineral structures using Pauling's first rule governing atomic coordination.
5. Relate the properties and stability of silicate minerals to the systematics of silicate crystal structures.
6. Use the chemical formula of minerals to predict their behavior and to write chemical reactions.

Essential Learning Requirements:

Even when Academic Consideration is granted for missed coursework, the following components are essential to earn a passing grade in this course: **7 of 9 Lab Assignments** (not including Lab 1, which is not graded); **7 of 9 Mineral Quizzes**; Mandatory completion of the **Final Lab Exam/Mineral Exam** and **Final Exam**.

When a student has not demonstrated proficiency in an essential learning requirement listed above, and when the shortfall results from a granted Academic Consideration, they will be withdrawn (WDN) from the course. The student may appeal to the Associate Dean (Academic) for reinstatement with an Incomplete (INC) standing. Where an appeal for INC is granted, their maximum course load may be reduced during the term in which they complete the outstanding course requirements

Course topics/themes - Tentative schedule			Reading in Text
Crystallography			Klein and Dutrow:
Week 0:	Sept 9	Introduction to mineralogy	Ch 1
Week 1:	Sept 14, 16	Physical properties of minerals; Point symmetry	Ch 2, 6
Week 2:	Sept 21, 23	Six crystal systems: symmetry & axes; Crystal forms & Miller indices	Ch 6
Mineral Chemistry			Klein and Dutrow:
Week 3:	Sept 28, 30	Periodic Table, chemical bonding, coordination polyhedra; NDTR	Ch 3-4
Week 4:	Oct 5, 7	Pauling's 1 st rule; Chemical substitution, solid solution, exsol ⁿ	Ch 3, 5, 11, 12
Week 5:	Oct 12, 14	***** Fall Reading Week *****	
Optical mineralogy			Nesse:
Week 6:	Oct 19, 21	Properties of polarized light; Optical properties of minerals	Ch 1, 3-5
Week 7:	Oct 26, 28	Optical properties cont'd, Uniaxial minerals (tetragonal, hexagonal)	Ch 6
Week 8:	Nov 2, 4	Midterm , Biaxial minerals (orthorhombic, monoclinic, triclinic)	Ch 7
Systematic mineralogy of rock-forming minerals			Klein and Dutrow:
Week 9:	Nov 9, 11	Structural principles of silicates; Orthosilicates & Ring silicates	Ch 18
Week 10:	Nov 16, 18	Single vs double chain silicates: pyroxenes, amphiboles	Ch 18-19
Week 11:	Nov 23, 25	Sheet silicates: clays to micas; Framework silicates: SiO ₂ polymorphs	Ch 18-19
Week 12:	Nov 30, Dec 2	Frameworks: feldspar; Non-silicates: native elements, oxides, sulfides	Ch 18-19
Week 13:	Dec 7, 9	Non-silicate minerals: carbonates; Flemming's research lecture	Ch 15

Laboratory topics:

Labs	Date	Crystallography/Optical Mineralogy	Quiz	Minerals
Week 1:	Sept 15, 16	Physical Properties of Minerals		no native elements, halides
Week 2:	Sept 22, 23	Point symmetry operations; six crystal systems	yes	oxides
Week 3:	Sept 29, 30	Cancelled due to National Day of Truth & Reconciliation (NDTR) on Sept 30		
Week 4:	Oct 6, 7	External morphology: crystal forms, Miller indices	yes	sulphides
Week 5:	Oct 13, 14	***** Fall Reading Week *****		
Week 6:	Oct 20, 21	Closest packing and coordination	yes	carbonates, sulphates
Week 7:	Oct 27, 28	Optical microscopy - plane & cross polarized light	yes	orthosilicates
Week 8:	Nov 3, 4	Optical microscopy – Anisotropic – uniaxial	yes	ring & chain sil.
Week 9:	Nov 10, 11	Optical microscopy – Anisotropic – biaxial	yes	sheet silicates
Week 10:	Nov 17, 18	Optical microscopy – Mafic igneous minerals	yes	framework silicate
Week 11:	Nov 24, 25	Optical microscopy – Felsic igneous minerals	yes	
Week 12:	Dec 1, 2	Optical microscopy – Metamorphic minerals	yes	
Week 13:	Dec 8 or 9	Final lab exam (We will decide which day by vote)	Final mineral exam	

Key Sessional Dates:

Classes begin: September 9, 2026

Fall Reading Week: October 10 – 18, 2026

Classes end: December 9, 2026

Exam period: December 11 – 22, 2026

4. Course Materials

Course Materials:

- *Manual of Mineral Science*, 23rd Ed. (2008), by C. Klein and B. Dutrow, Wiley. (Required)
- *Introduction to Optical Mineralogy*, 4th Ed. (2012) by W.D. Nesse, Oxford University Press (Optional).
- Supplementary material will be given weekly, posted to OWL: <https://westernu.brightspace.com/>.

Cost of textbooks and other learning materials:

- *Manual of Mineral Science*, 23rd Ed.: E-book, 150 day Rental: \$79; E-book: \$178; hardcopy: \$292.
[Or you can use previous edition: *Manual of Mineral Science*, 22nd Ed. (2002), by C. Klein, Jr, Wiley.]
- *Introduction to Optical Mineralogy*: Out of print. Purchase used from Amazon starting at ~\$107.
[Or you can use the previous editions.]

All course material will be posted to OWL: <https://westernu.brightspace.com/>

Students are responsible for checking the course OWL site (<https://westernu.brightspace.com/>) regularly for news and updates. This is the primary method by which information will be disseminated to students in class.

If students need assistance with the course OWL site, they can seek support on the [OWL Brightspace 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

Midterm class test: (50 minutes)	November 2	20 %
Lab assignments:	Weekly (9) Due the week following the lab	20 %
Lab mineral quizzes:	Weekly (9)	10 %
Lab exam: (2 hours)	Dec 8 or 9 (as determined by class VOTE)	20 %
Final exam: (3 hours)	TBD - Scheduled by the Registrar	30 %

No electronic devices may be used during tests/exams. Non-programmable calculators are acceptable. All **EXAMS** and **QUIZZES** in this course are **closed book**; they are **not collaborative**.

Use of Generative AI Tools

AI tools (e.g., ChatGPT, Copilot, Gemini) are **prohibited**.

Information about Missed Coursework

Students must familiarize themselves with the *University Policy on Academic Consideration – Undergraduate Students in First Entry Programs*, posted on the Academic Calendar:

https://uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf,

This policy does not apply to requests for Academic Consideration submitted for attempted or completed work, whether online or in person. The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult [Accessible Education](#).

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar's webpage: https://registrar.uwo.ca/academics/academic_considerations/

All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

Midterms and Tests

This course has a midterm test and a **cumulative** final exam. There is no makeup test for a missed midterm. If a student misses a midterm, its weight will shift automatically to their final exam grade. If their final exam grade is higher than their midterm grade, their final exam grade will replace the midterm's weight in their overall grade. They do not need to request Academic Consideration for a missed midterm; the reweighting will be done automatically.

The only exception is an early sitting, offered solely for a university-sanctioned schedule conflict (e.g., conflict of two midterms, Varsity competitions) or a religious accommodation that prevents a student from writing the midterm at its scheduled time. If a student requires this accommodation, they must notify their instructor in writing no later than one week before the test. No other circumstance, including illness, qualifies for an early sitting or makeup; these are addressed by the automatic reweighting described above.

Further note about midterm test:

It is Faculty of Science policy that a student who chooses to write a test or exam deems themselves fit enough to do so. Claims of medical, physical, or emotional distress after the fact will not be considered, however, if a student improves their grade in their final exam by 10% over their grade in the midterm test, the student may qualify to have the final exam given full weight (50%) and the midterm grade discounted.

Lab Assignments and Quizzes:

This course has 9 lab assignments and 9 quizzes. Students are expected to complete 7 of 9 assignments and 7 of 9 quizzes to receive full credit for this component. If they miss up to 2 of these, they do not need to request Academic Consideration; the missing item(s) will not count against them, and their grade for this component will be calculated from their best 7 submissions.

The skills learned/assessed in the laboratory are essential to this course. They will be further assessed through the **final laboratory exam/final mineral quiz**. Students must complete the **final lab exam/final mineral quiz** to meet the requirements of the course. See Essential Learning Requirements above for clarification.

Deadlines: The 48-Hour No-Late-Penalty Period

All take-home assignments, quizzes, and labs with a stated due date include an automatic 48-hour period after the deadline during which students may still submit without a late penalty. For example, if an assignment is due on November 5, they may submit it until November 7 without penalty. After this 48-hour period, no further submissions will be accepted, and students do not need to request Academic Consideration for a missed deadline; their grade for this component will be calculated as described above.

However, **the following assessments are excluded** from the above policy, and therefore always require formal supporting documentation (as defined by policy): **Final Lab Exam & Final Exam** scheduled by the registrar.

Special Examination

Per university policy, Academic Consideration requests with supporting documentation are required for the final examinations scheduled during official examination periods by the Registrar's Office.

If the student has been approved by the Academic Advising Office to write a Special Examination (SPC) and the final exam is their only outstanding course component, an SPC will be assigned to them and scheduled by the instructor per university policy.

If the student misses their SPC exam and is approved for Academic Consideration, they will be withdrawn from the course without academic penalty. If they experienced extenuating circumstances such as prolonged illness, they may appeal to the Associate Dean (Academic), on a case-by-case basis, for the opportunity to write the final exam the next time the course is offered. An outstanding SPC will reduce their course load for the term in which the exam is deferred, as outlined in the [Definitions of Types of Examinations](#) policy.

If the student misses their SPC exam and Academic Consideration is not approved, or was not requested, they will receive a grade of zero on the exam.

6. Additional Statements

6.1 Religious Accommodation

When a recognized religious holiday either requires a student to be absent from the University, or requires or prohibits an activity that makes it impossible for them to complete an academic requirement scheduled that day, they are entitled to accommodation. No student will be penalized for an absence for religious reasons, and an alternative means of satisfying the requirement will be arranged. This accommodation is provided in accordance with the University's policy on Accommodation for Religious Holidays:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

The student should submit their requests through the Student Absence Portal (SAP), identifying the conflict and the specific course component(s) affected (e.g., test, midterm, exam).

Midterms and Tests: If a religious observance conflicts with a midterm test, they must submit their request no later than **one week** before the test. Their instructor will arrange an early sitting of the test. As set out above, no makeup test is offered for any other reason; this early sitting is available specifically for this accommodation.

Final Examinations: If a religious observance conflicts with the final exam, the student must submit their request no later than **two weeks** before the exam. Their instructor will arrange a Special Examination to take place no later than one month after the end of the examination period.

Students are responsible for finding out what was covered in any class they miss due to a religious observance, and for taking the appropriate steps to keep up with the course.

If a suitable arrangement cannot be reached between a student and their instructor, they should consult the Undergraduate Chair of the department offering the course, and if necessary, the Associate Dean (Academic) of the Faculty of Science.

For a list of recognized religious observances, please visit the calendars posted on the Equity, Diversity & Inclusion website - <https://www.edi.uwo.ca> (About Us – Resources – Additional Resources – Calendars).

6.2 Academic 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.

6.3 General Academic Policies

The website for Registrar Services is <https://www.registrar.uwo.ca/>.

Use of @uwo.ca email: 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 email address. It is the responsibility of the account holder to ensure that emails received from the University at their official university address are attended to in a timely manner.

Requests for Relief (formally known as “appeals”)

Policy on Request for Relief from Academic Decision:

https://uwo.ca/univsec/pdf/academic_policies/appeals/requests_for_relief_from_academic_decisions.pdf

Procedures on Request for Relief from Academic Decision (Undergraduate):

https://uwo.ca/univsec/pdf/academic_policies/appeals/undergrad_requests_for_relief_procedure.pdf

6.4 Scholastic Offences

Policy on Scholastic Offences: https://uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_offences.pdf

Procedures on Scholastic Offences (Undergraduate):

https://uwo.ca/univsec/pdf/academic_policies/appeals/undergrad_scholastic_offence_procedure.pdf

Use of Electronic Devices During Assessments

In courses offered by the Faculty of Science, the **possession** of unauthorized electronic devices during any in-person assessment (such as tests, midterms, and final examinations) is strictly prohibited. This includes, but is not limited to: mobile phones, smart watches, smart glasses, hidden cameras and wireless earbuds.

Unless explicitly stated otherwise in advance by the instructor, the presence of any such device at a student's desk, on their person, or within reach during an assessment will be treated as a scholastic offence, **even if the device is not in use**.

Effective September 2026, the typical penalty for this offence is a failing grade in the course AND a 12-month prohibition on retaking the course.

Only devices expressly permitted by the instructor (e.g., non-programmable calculators) may be brought into the assessment room. It is their responsibility to review and comply with these expectations.

Use of Generative AI Tools

Unless otherwise stated, the use of generative AI tools (e.g., ChatGPT, Microsoft Copilot, Google Gemini, or similar platforms) is **not permitted** in the completion of any course assessments, including but not limited to: assignments, lab reports, presentations, tests, and final examinations.

Using such tools for content generation, code writing, problem solving, translation, or summarization—when not explicitly allowed—will be treated as a **scholastic offence**.

If the use of generative AI is permitted for a particular assessment, the conditions of use will be specified by the instructor in advance. If no such permission is granted, students must assume that use is prohibited. It is the student's responsibility to seek clarification before using any AI tools in academic work.

Use of Software for Assessments

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>).

6.5 Support Services

Academic Advising. Please visit the Science & Basic Medical Sciences Academic Advising webpage for information on adding/dropping courses, academic considerations for absences, requests for relief, exam conflicts, and many other academic-related matters: <https://www.uwo.ca/sci/advising/>.

Mental Health Support. 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.

Gender-Based and Sexual Violence. Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who has gone through these traumatic events. If a student has experienced GBSV (either recently or in the past), they can 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.

Accessibility for Coursework. A student may contact the course instructor if they require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to them. If they have any questions regarding accommodations, they may also contact Accessible Education at http://academicsupport.uwo.ca/accessible_education/index.html

Learning Development and Success. Learning-skills counsellors at Learning Development and Success (<https://learning.uwo.ca>) are ready to help students improve their learning skills. The facility offers strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Student Councils.

Student-run support services are offered by the University Students' Council (<https://westernusc.ca>) and the Science Students' Council (<https://www.westernssc.ca>).

This course is supported by the Science Student Donation Fund. Students registered in the Faculty of Science or the Schulich School of Medicine and Dentistry contribute a Science Student Donation Fee. This fee contributes to the Science Student Donation Fund, which is administered by the Science Students' Council (SSC). One or more grants from the Fund have allowed for the purchase of equipment integral to teaching this course. Students may opt out of the Fee by the end of September of each academic year by completing the online form linked from the Faculty of Science's Academic Advising site. For further information on the process of awarding grants from the Fund or how these grants have benefitted undergraduate education in this course, consult the Chair of the Department or email the Science Students' Council at info@westernssc.ca.