Western Science

Department of Earth Sciences

Earth Sciences 2220b: Environmental and Exploration Geophysics I
Course Outline – Winter 2022

1. Course Information

ES2220b – Environmental and Exploration Geophysics
Lectures: Tue/Thu: 12:30 p.m. – 1:30 p.m., **NCB-293**
Labs: Fri: 10:30 a.m. – 1:30 p.m., **B&GS-0184**

List of Prerequisites: 0.5 course from Calculus 1000A/B or Calculus 1500A/B, Mathematics 1225A/B or equivalent (please refer to the UWO Calendar).

Unless you have either the requisites for this course or written special permission from your Dean 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 in the event that you are dropped from a course for failing to have the necessary prerequisites.

2. Instructor Information

Instructors	Email	Office	Phone	Office Hours
Dr. Robert Shcherbakov (Course Instructor)	rshcherb@uwo.ca	B&GS 1080	x84212	By appointment
TA				

3. Course Syllabus, Schedule, Delivery Mode

This course provides a brief introduction to the discipline of applied seismology - the branch of geophysics that investigates earthquakes, and Earth structure using sound waves in rocks. The source of seismic waves can be either artificial (e.g., an explosion, vibrational device or a hammer blow), or natural (most often earthquakes). In many ways, seismology is to the Earth Sciences what radiology is to Medicine; it is our window into the Earth's interior, providing a way to map and study, in situ, the inner workings of our planet at different scales.

Several different seismic methods are in common use. Seismic-reflection methods, a cornerstone of oil and gas exploration in sedimentary basins, use a large number of detectors, or geophones, located close to the seismic source. Reflection techniques are mainly used for creating highly resolved images of the Earth's interior. Modern applications use areal arrays of sources and receivers to render these images in three-dimensions. Seismic-refraction methods use detectors that are spread over a greater distance relative to the target depth. These methods are mainly used for measuring the seismic velocity of the subsurface, from which quantitative information about rock type and physical conditions can be inferred. Both methods are commonly used on either land or sea, at scales of investigation from a few m (environmental applications) to hundreds of km (crustal studies).

This is a lab-oriented course that will provide extensive hands-on computer experience, particularly with the general-purpose numerical analysis program Matlab. Geophysical concepts will be

emphasized, but underlying mathematical principles will also be discussed where needed to gain a complete understanding of the methods and their applications.

Course Objectives and Learning Outcomes:

Upon successful completion of this course, students will be able to:

- describe and identify basic aspects of several exploration seismology methods;
- discriminate between geological and geophysical approaches to investigate the subsurface structure of the Earth;
- identify the key aspects of a typical workflow of the geophysical exploration methods comprising data acquisition, processing, and interpretation;
- describe the environmental impacts of exploration and consequences following large devastating earthquakes;
- apply the skills required to work with the scientific computer software Matlab.

Summary of Lecture Topics (*approximate and subject to change*!)**:**

- Introduction and Outline. What is geophysics.
- Geophysical methods and data analysis.
- Waves, pulses, rays. Seismic waves.
- Wave propagation. Reflection and refraction.
- Body and surface waves.
- Forces and deformation. Stress and strain.
- Global seismology. Internal structure of the Earth.
- Seismic-refraction method: Basic principles and techniques.
- Seismic reflection-methods: Data acquisition, basic processing, interpretation, 3-D methods and case histories.
- Earthquakes and global seismology.
- Earthquake magnitude and seismic moment.
- Seismicity and earthquake statistics.
- Introduction to Ground Penetrating Radar.

Course Work

The lecture and laboratory components cover theory and "hands-on" components of the course, respectively. Lab/tutorials will be held in the ES computer labs. Lecture notes and assignments are going to be available through OWL (http://owl.uwo.ca/portal).

Assignments will consist of examination-style short-answer questions and require no formal writeup. In many cases, assignments will require the use of Matlab. Unless indicated otherwise, assignments should be submitted to the TA at the beginning of the next lab/tutorial session. Late submissions will be accepted with a 5% per day penalty. Under exceptional circumstances, late submissions will be accepted with no penalty, provided that adequate documentation is given. With a few exceptions, only SI units should be used to report any physical quantities.

The midterm exam will be held during the class period on Tuesday, March 1. The final exam will be **two hours** in length and will take place during the April examination period. For both exams, a **single-sided hand-written crib sheet** and a non-programmable calculator may be used.

The project will involve a written report (single-sided, double-spaced ~5 pages + figures). The topic will be chosen by the student and approved by the instructor before February 18. Research topics must be in the field of seismology. Possible topics include: a review of a specific seismogenic region or fault system; discussion of a notable earthquake; discussion of the role of seismic methods in exploration; review of a seismic technique not covered in the course. The project must include references to the scientific literature. Projects are due on April 5. *(**Plagiarism:** Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).)*

The relevant Key Sessional Dates:

Classes begin:	January 3, 2022
Reading Week:	February 19–27, 2022
Classes end:	April 5, 2022

Contingency plan for an in-person class pivoting to 100% online learning

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will **not** change. Any remaining assessments will also be conducted online as determined by the course instructor.

4. Course Materials

Required Textbook:

- Mussett, A.E. and Khan, M.A., ***Looking into the Earth: An Introduction to Geological Geophysics***, Cambridge University Press, 2000.

Other Recommended Textbooks:

- Dentith M. and Mudge S.T., ***Geophysics for the Mineral Exploration Geoscientist***, Cambridge University Press, 2014.
- Kearey, P., Brooks, M., Hill I., ***An Introduction to Geophysical Exploration***, Blackwell, 2002.
- Reynolds, J.M., ***An Introduction to Applied and Environmental Geophysics***, Wiley, 2011.
- Sheriff R., and Geldart L., ***Exploration Seismology***, Cambridge University Press, 1995.
- Stein, S. and Wysession, M., ***An Introduction to Seismology, Earthquakes, and Earth Structure***, Blackwell, 2003.

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

The overall course grade will be calculated as listed below:

Assignments	Midterm Exam	Final Exam	Participation	Project
20%	20%	30%	5%	25%

6. Student Absences

Academic Consideration for Student Absences

Students who experience an extenuating circumstance (illness, injury or other extenuating circumstance) sufficiently significant to temporarily render them unable to meet academic requirements may submit a request for academic consideration through the following routes:

(i) Submitting a Self-Reported Absence (SRA) form provided that the conditions for submission are met. To be eligible for a Self-Reported Absence:

- an absence must be no more than 48 hours
- the assessments must be worth no more than 30% of the student's final grade
- no more than two SRAs may be submitted during the Fall/Winter term

(ii) For medical absences, submitting a Student Medical Certificate (SMC) signed by a licensed medical or mental health practitioner to the Academic Counselling office of their Faculty of Registration.

(iii) Submitting appropriate documentation for non-medical absences to the Academic Counselling office in their Faculty of Registration.

Note that in all cases, students are required to contact their instructors within 24 hours of the end of the period covered, unless otherwise instructed in the course outline.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For the policy on Academic Consideration for Student Absences – Undergraduate Students in First Entry Programs, see:

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

and for the Student Medical Certificate (SMC), see:

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

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.

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 are able to 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).

6. Accommodation and Accessibility

Accommodation Policies

Students with disabilities work with Accessible Education (formerly SSD), 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,

7. Academic Policies

The website for Registrarial 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 his/her official university address is attended to in a timely manner.

For the exams a non-programmable calculator is required. A single-sided hand-written crib sheet can be used for formulas and definitions.

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).

8. 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/.

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 (519) 661-2147 if you have any questions regarding accommodations.

Learning-skills counsellors at the Student Development Centre (http://www.sdc.uwo.ca) are ready to help you improve your learning skills. They offer presentations on 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.

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

Additional student-run support services are offered by the USC, http://westernusc.ca/services.