Earth Sciences 2220: Environmental and Exploration Geophysics I
Course Outline – Fall 2013

Course Instructor: Sean Shieh (office: B&GS 1066; e-mail: sshieh@uwo.ca)
Lectures: Tuesday and Thursday, 12:30 p.m. – 1:30 p.m., UCC room 53
Labs: Wednesday, 2:30 p.m. – 5:30 p.m., **B&GS 0184**
Office Hours: By appointment

Course TA's: Luqi Cui (lcui24@uwo.ca)

Course description:

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.

Prerequisites: 0.5 course from Calculus 1000A/B, Calculus 1100A/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 will 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.)

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:

- Kearey, P., Brooks, M., Hill I., **An Introduction to Geophysical Exploration**, Blackwell, 2002.
- Reynolds, John M., **An Introduction to Applied and Environmental Geophysics**, Wiley, 2011.
- Lay, T. and Wallance, T.C., **Modern global seismology**, Academic Press, 1995.
- 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.

Course Work

The lecture and laboratory components cover theory and "hands-on" components of the course, respectively. Lab/tutorials will be held in the computer lab (room B&GS 0184). Lecture notes and assignments are going to be available through WebCT (http://webct.uwo.ca).

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 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 October 10. 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 December 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 midterm exam will be held during the class period on Thursday, October 24. The final exam will be two-three hours in length and will take place during the Final examination

period. For both exams, a **single-sided hand-written crib sheet** and a non-programmable calculator may be used.

Method of Evaluation:

Assignments and Labs	Project	Midterm Exam	Final Exam
20%	20%	25%	35%

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

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

Note: Assignments are not all of equal value for calculating final grades.

Statement on Academic Offences: "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/handbook/appeals/scholoff.pdf ."

Statements on special circumstances:

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see: http://www.uwo.ca/univsec/handbook/appeals/medical.pdf

A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Dean's Office) for visits to Student Health Services. The form can be found here:

https://studentservices.uwo.ca/secure/medical_document.pdf

Accessibility statement: Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x.82147 for any specific question regarding an accommodation.