

Earth Sciences 3321a - Fall 2024

1. <u>COURSE INFORMATION</u>

Location: In person delivery

Time Zone: All times given are Eastern Daylight Time (EDT)

3 Lectures per week <u>in person</u>

PDF files of lectures will be available on the OWL course site before the lecture times given above.

1 **Tutorial** session per week will be scheduled and used as needed <u>in person</u>

The tutorial sessions will be used for the following purposes:

for discussion of minor and major assignments

to help guide you in choosing a topic and carrying out literature search for your major

presentation (seminar)

for lectures on odd occasion for seminar presentations by students at the end of term more tutorial details are available on the OWL course site under Resources

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

In the event there is cause that necessitates the course delivery moving away from face-to-face interaction, affected 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.

<u>1a. Prerequisites</u> Earth Sciences 2220A/B or the former 2221A/B or special permission.

Unless you have either the prerequisites for this course or written special permission from your Dean to enrol 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

Technical Requirements

iv. **Physics of Minerals – 5 lectures**

transport properties overview

- driving force, flux, material properties

- electrical conduction
 - band theory concepts
 - metallic and semi-conduction
 - ionic, hopping (vacancy and intervalence charge transfer) conduction
 - ionic diffusion, Nernst-Einstein equation
- mantle electrical conductivity structure
 - high P,T experiments

- lower mantle conductivity derived from geomagnetic variations (1969 Jerk) core electrical conductivity

rheology

- types of rheology
- momentum carriers
- creep mechanisms
- mantle rheology

<u>**Course-Level Learning Outcomes</u>**: Upon successful completion of this course, students will be able to:</u>

* Explain quantitatively the major processes responsible for planetary accretion as well as the observational evidence that supports the accepted accretion model.

* Describe the historical development of global seismology and use important equations to develop a model of Earth interior structure from travel time and free oscillation data that is consistent with a compositional model of the interior.

* Explain the sources of interior heat and using equations and the physics of heat transfer, describe quantitatively heat conduction and convection within the Earth as a basis for its heat engine behavior.

* Explain the physics of electrical conduction and rheology and its application to the geomagnetic field as well as the flow of matter in the mantle.

* Through practice in weekly exercises, capture and convey the main aspects of a published scientific article in Earth Physics by describing in less than one written page : the study purpose, method(s) used, results, application of results to the problem, and further study suggested.

* Through practice in a major oral presentation, communicate to a scientifically literate audience any major topic within the areas of solar system formation, earth interior structure, terrestrial heat flow and mineral physics.

<u>4. COURSE MATERIALS</u>

Course Materials / Course Website:

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

Students are responsible to check OWL (https://westernu.brightspace.com/) on a regular basis for news and updates. This is the primary method by which information (lectures, labs, announcements,

assignments, forum, etc) will be disseminated to all students in the class.

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

There is no text book for this course but the lecture material may be found in the general and more specific reference books listed below. Some of the books may be found on-line (including the titles in italics).

General Reference Books

FUNDAMENTALS OF GEOPHYSICS, W. Lowrie, Cambridge University Press, 1997. PHYSICS OF THE EARTH 3rd ed., F. D. Stacey, Brookfield Press, 1992. *PHYSICS OF THE EARTH 4th ed.*, F. D. Stacey and P.M. Davis, Cambridge University Press, 2008.

THE SOLID EARTH C.M.R. Fowler, Cambridge University Press, 1990.
THE APPLICATION OF MODERN PHYSICS TO THE EARTH AND PLANETARY INTERIORS. S.K. Runcorn ed. Wiley, 1969.
THE INTERIOR OF THE EARTH, 2nd ed., M.H.P. Bott, Edward Arnold, 1982.
INTRODUCTION TO GEOPHYSICS, G.D. Garland, W.B. Saunders Co., 1979.
THE EARTH, H. Jeffreys, Cambridge University Press, 6th edition, 1976.

Specific Reference Books

Section 1

ORIGIN OF THE EARTH AND MOON, A.E. Ringwood, Springer Verlag, 1979. METEORITES; THEIR RECORD OF EARLY SOLAR SYSTEM HISTORY, J.T. Wasson, Freeman, 1985. AN INTRODUCTION TO PLANETARY PHYSICS, W.M. Kaula, Wiley, 1968.

Section 2

THE EARTH'S DENSITY, K.E. Bullen, Wiley, 1975. DEEP INTERIOR OF THE EARTH, J.A. Jacobs, Chapman & Hall, 1992. THE EARTH'S CORE, 2nd edition, J.A. Jacobs, Academic Press, 1987.

Section 3

THE INACCESSIBLE EARTH, 2nd ed., G.C. Brown and A.E. Mussett, Chapman & Hall, 1993. THEORY OF THE EARTH, D.L. Anderson, Blackwell Sci. Pubs., 1989.

Section 4

 INTRODUCTION TO THE PHYSICS OF THE EARTH'S INTERIOR, J-P. Poirier, Cambridge University Press, 1991.
 INTRODUCTION TO THE PHYSICS OF ROCKS, Y. Gueguen and V. Palciauskas, Princeton Univ. Press, 1994.

Course Grade Evaluation

The final grade will be calculated with the following approximate distribution :

2 Major Assignments 10% : You must submit any 2 of 3 major assignments. If you choose to submit 3 major assignments, only the first 2 assignments will be graded.

2 Minor Assignments 5% : You must submit any 2 of 3 minor assignments. If you choose to submit 3 minor assignments, only the first 2 assignments will be graded.

Seminar oral presentation	10%
Seminar written report	10%
Midterm	30%
Final Exam	35%

6. STUDENT ABSENCES

General information about missed coursework

Students must familiarize themselves with the

7. ACCOMMODATION AND ACCESSIBILITY

Religious Accommodation

When conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request an accommodation for their absence in writing to the course instructor and/or the Academic Advising office of their Faculty of Registration. This notice should be made as early as possible but not later than two weeks prior to the writing or the examination (or one week prior to the writing of the test).

Please visit the Diversity Calendars posted on our university's EDID website for the recognized religious holidays:

https://www.edi.uwo.ca.

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 Registrar Services is https://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

NOTE: At the time of writing, this course is planned for in person delivery of lectures, tutorials, midterm test and exam. Should there be a university-mandated switch to on-line course delivery at any time during this term, the following statements will apply.

Tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at:

https://remoteproctoring.uwo.ca.

Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. Information about the technical requirements are available at the following link:

https://www.proctortrack.com/tech-requirements/

Tests and examinations in this course may be conducted using Zoom. You will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session will not be recorded *

More information about the use of Zoom for exam invigilation is available in the Online Proctoring Guidelines at the following link: https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf

Completion of this course will require you to have a reliable internet connection and a device that meets the system requirements for Zoom. Information about the system requirements are available at the following link:

https://support.zoom.us/hc/en-us

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please provide this information to the instructor in advance of the test or examination.

Tests and examinations in this course may be conducted using both Zoom and a remote proctoring service, such as Proctortrack.

When Zoom is used for exam invigilation, you will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam. The exam session using Zoom will not be recorded.*

Proctortrack will require you to provide personal information (including some biometric data). The session will be recorded. By taking this course, you are consenting to the use of this software. More information about remote proctoring is available in the Online Proctoring Guidelines at the following link:

https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf

Additional student-run support services are offered by the USC, <u>https://westernusc.ca/services/</u>.