

# **Earth Sciences 3321- PHYSICS OF THE EARTH I**

Fall 2013

Lecturer: Sean Shieh (BGS Room 1066, sshieh@uwo.ca)

## **COURSE DESCRIPTION**

An introduction to physics of the Earth's interior with emphasis on Earth's structure from seismic observations, heat flow, the physics of minerals under high pressures and high temperatures, equation of state, seismological, thermal and compositional models.

3 Lectures (Tue. Wed. Thu 10:30-11:20) Room 1065 BGS

Lab (Tue. 13:30-15:30) Room 0184 BGS

## **PREREQUISITES**

Completion of second year of any Geophysics program or special permission.

**Note:** 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.

## **COURSE OUTLINE\***

### 1. Solar System

Formation of planetary system

- Solar system characteristics
- Kepler's law
- Light and Energy
- Accretionary sequence

Meteorites

- Chondrites, achondrites, stony-irons, irons
- Carbonaceous chondrites
- Primitive composition

### 2. Global Seismology

Earth structure from body wave data

Elasticity and equations of state

Adams-Williamson equation, density models

PREM

Internal constitution

- compositional Earth models from seismological models
- mineralogy models of the mantle
- core compositional models

-inner core elastic anisotropy, super-rotation

### 3. Physics of Minerals

Phase transformation

Transport properties overview

-driving force, flux, material properties

Electrical conduction

- band theory concepts

- metallic and semi-conduction

Mantle structure

- high P, T experiments

- lower mantle dynamics

- enigma of D'' layer

Core electrical conductivity

- geodynamo constraints

- thermal constraints

### 4. Thermal State

Thermal conduction (lattice and electronic)

Heat flow

Heat conduction equation

Heat transport

Geotherm

- upper mantle constraints: peridotites, kimberlites, olivine-ringwoodite, perovskite + ferropericlase

- lower mantle constraints: adiabat, high P, T melting experiments on perovskite and ferropericlase

- core constraints: high P, T melting experiments on iron at inner core boundary conditions, adiabat

Mantle convection

- layered vs. whole mantle

Core convection

\* Contents may change upon necessity.

## **ASSIGNMENTS**

Assignments on topics related to the above sections, though not necessarily specifically discussed in the lectures, will be set during term time. Some questions may require extra reading/study and you are therefore encouraged to refer to the books listed below (or any other book). Late submissions will be subject to reduction at a rate of 20% per day. Missed assignments will receive a grade of zero.

## **Midterm and Final**

Midterm will be held on October 29 during class and final exam will follow University schedule.

## **SEMINAR**

Each student will be required to present a seminar and hand in a written report (<10 pages, including figures, tables and references) on an approved topic of her/his choice. Seminars will be given at a date to be determined near the end of term. Details will follow.

## **GRADE**

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

Assignments	20%
Seminar	20%
Midterm	20%
Final Exam	30%
Attendance, participation, quiz and others	10%

## **REFERENCE BOOKS**

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.

### General

Fundamentals of Geophysics, W. Lowrie, Cambridge University Press, 1997.

Physics of the Earth 3<sup>rd</sup> ed., F.D. Stacey, Brookfield Press, 1992.

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, 2<sup>nd</sup> ed., M.H.P. Bott, Edward Arnold, 1982

### 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, 2<sup>nd</sup> edition, J.A. Jacobs, Academic Press, 1987.

### Section 3

Introduction to the Physics of the Earth's Interior, J-P. Poirier, Cambridge University Press, 2000 (2nd ed.).

New Theory of the Earth, D.L. Anderson, Cambridge University Press, 2007.

#### Section 4

The Inaccessible Earth, 2<sup>nd</sup> ed., G.C. Brown and A.E. Mussett, Chapman & Hall, 1993.

New Theory of the Earth, D.L. Anderson, Cambridge University Press, 2007.

#### **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](https://studentservices.uwo.ca/secure/medical_document.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> )."