

# **ES 4424 ADVANCED MINERAL PHYSICS**

Winter 2016

Lecturer: Sean Shieh

Room 1066, B&G Bldg

## **COURSE DESCRIPTION**

The course introduces elementary solid state theory, thermodynamics, high pressure-temperature geophysics, phase transformations, elasticity, physical properties, mineral physics of mantle and core. This course aims to introduce how to study the physical and mechanic properties of materials at ambient and extreme conditions.

Lectures: Tue, Thu 11:30-12:30, Room 1084 B&GS

Lab: Tue 2:30 - 4:30 PM Room 0182, B&GS

## **PREREQUISITES**

Earth Sciences 3321A/B or permission of the Department.

“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**

The following topics represent a general overview of the course.

However, readings that will be assigned may cover other topics as well.

### **Thermodynamics of Solids**

- Thermodynamic potentials

- Maxwell relations

- Elastic moduli

- Thermoelasticity (lattice harmonicity / anharmonicity)

- Grüneisen parameter

### **Physical Properties of Solids**

- Elasticity

- Bonding property

- Equations of state

- Thermoelasticity

- Stress and strength

### **High Pressure and Temperature Generating Devices**

- Static methods (large volume press, diamond-anvil cell)

- Dynamic methods (shock wave)

- Pressure determination

- Lattice vibration

### **Transport Properties**

- Melting

- Charge, energy, mass transport

Viscosity  
Mantle rheology

### **Mineral Physics Constraints on Mantle and Core**

Properties  
Composition  
Interaction

### **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).

### **SEMINAR**

You will be required to present a seminar and hand in a written report on an approved topic of your choice which is related to topic of this course. The report should be no more than 10 pages, including references. Seminars will be given at a date to be determined near the end of term. Details will follow.

### **Midterm and Final**

Midterm will be held around but not in the reading week and final exam will follow University schedule.

### **GRADE**

The final grade will be calculated with the approximate breakdown as follows:

Assignments and quizzes 20%  
Midterm 20%  
Seminar 25%  
Final Exam 30%  
Class participation 5%

### **TEXT BOOK**

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

### **REFERENCE BOOKS**

Physics of the Earth 3rd ed., F. D. Stacey, Brookfield Press, 1992. (library has 2nd edition, 1977)  
New Theory of the Earth, D.L. Anderson, Cambridge University Press, 2007.  
Advances in High-Pressure Mineralogy, E. Ohtani, GSA, 2007.  
The Physics of High Pressure, P.W. Bridgman, G. Bell and Sons, 1958.  
Kittel, C., Introduction to Solid State Physics, 5<sup>th</sup> Edition, John Wiley and Sons, New York, 1976.

"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>."

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> )."