

ES 4424 ADVANCED MINERAL PHYSICS

Instructor: Sean Shieh, B&GS room 1066 (email: sshieh@uwo.ca)

Lectures: Tue, Thu 12:30-13:30

Lab: 2:30 - 4:30 PM

COURSE DESCRIPTION

The course introduces elementary solid state theory, thermodynamics, elasticity, equation of state, stress and strength, phase transformations, high pressure and high temperature science and technique, 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 and how they can be applied to nature and industry system.

PREREQUISITITES: N/A

LEARNING OUTCOME:

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

- Explain the basic concept of the thermodynamics and their relations to the properties of materials
- Explain the basic concept of the crystal chemistry and physics and their responses to extreme pressure and temperature conditions
- Explain the basic concept of the equation of state and spectroscopy and their relations to elastic property of the materials
- Explain the basic concept of the stress and stress and their relations to mechanical property of the materials
- Explain the basic concept of the high pressure apparatus and their applications to the study of formation and evolution of the planetary bodies.
- Apply the knowledge of mineral physics to the synthesis, structure and elasticity of the materials under ambient and extreme conditions

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
Electrical conductivity
Thermal conductivity
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 on an approved topic of your choice which is related to topic of this course. Seminars will be given at a date to be determined near the end of term. Details will follow.

FINAL REPORT

You will be required to 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 figures and tables but not references. Format: Time New Roman, font size 12, double spacing,

MIDTERM

Midterm will be held around but not in the reading week.

GRADE

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

Assignments 30%
Midterm 25%
Seminar 25%
Final report 20%

TEXT BOOK (Recommended)

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, 5th Edition, John Wiley and Sons, New York, 1976.

Additional Statements (PLEASE READ)

The instructor owns the IP in the lecture and lecture materials even when such lectures or materials are posted online and students are not to post lectures or lecture materials to any other websites or platforms or use the lecture recording or materials for any other purpose without your consent. It also prohibits the recording of live lectures or recorded lectures.

"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

"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>)."