

University of Alberta

EAS 421 Structural Geology and Tectonics

Fall 2010

Lecture Room & Time: TBW2; MWF 10-11
Labs: ESB 1-06 MTh 2-5

Instructor: John W.F. Waldron
Office: ESB 4-10 (subject to change)
Telephone: 780 492 3892
E-mail: john.waldron@ualberta.ca
Web Page: <http://courses.eas.ualberta.ca/eas421>
Office Hours: MWTh 11-12

Teaching assistants: Hayley Pothier ESB 2-04D
 Shawna White ESB 3-08

About the course

Course Description: Geometric, kinematic, and dynamic analysis of structures produced by deformation. Stress and the origin of faults, joints, veins, folds, and tectonites. Brittle and ductile strain in rocks. Extensional, strike-slip, and compressional structural associations. Regional structure, orogens, and crustal tectonics. Lab exercises include structural interpretation for subsurface hydrocarbon and mineral exploration, stereographic techniques for structural analysis, and the study of rock fabrics.

Course Prerequisites: EAS 233 and any 300-level EAS course. Not available to students with credit in EAS 321

Course Objectives and Expected Learning Outcomes:

The objectives of structural geology and tectonics fall into three categories, which will be continuing themes in the lectures and labs.

- **Geometry:** Learn how to describe the **shapes and three-dimensional orientations** of structures in deformed rocks at all scales. You will have encountered many of these structures in EAS233 Geologic structures and maps. EAS 421 builds on this experience.
- **Kinematics:** Learn the methods that can be used to interpret the **movements** that have that have affected the Earth's lithosphere, over time.
- **Dynamics:** Learn what can (and cannot) be deduced about **forces** involved in the deformation of the Earth's lithosphere.

The emphasis in structural geology is on solving problems, not on learning facts. For these reasons, the laboratory sessions are particularly important.

Classes

Lectures

Lectures take place MWF at 10 am. Please be respectful of your instructor and other students by being on time and by not talking or causing other distractions in class. If you carry a cell phone make sure it is off during lectures. Handouts may be provided at the start of some lectures. If you have to miss a lecture for some medical or other unavoidable reason, try to have a 'lecture buddy' who can make notes for you and collect any handouts. I do not bring copies of previous handouts to subsequent lectures. **Note:** Recording is permitted only with the prior written consent of the professor or if recording is part of an approved accommodation plan.

Labs

You will be registered in either the Monday (D1) or the Thursday (D2) lab. You must stick to your assigned lab unless you have a particular reason for changing labs in a given week, which must be approved by your TA. Note that there are gaps in the lab schedule for both the Monday and the Thursday lab to deal with holidays and other special events. It is important to consult this schedule; do not assume, when there is no Monday lab, that the Thursday class is also cancelled! Note that different classes deal with the holidays in different ways. Do not assume that your other classes will have the same lab schedule.

For each lab you should have the following available:

- Tracing paper, Graph paper, a ruler at **least 30 cm long** (11.81 inches)
- A calculator with scientific functions
- Lead pencils that are sharp and **can be kept sharp** (old fashioned pencils and a sharpener, or mechanical pencils with 0.5 mm leads).
- A good eraser.
- Some coloured pencils ('pencil crayons'). Please note that these are useful for labelling structures in diagrams but must never be used for accurate constructions!

While working in the lab, please respect the general lab rules. In addition, please adhere to the following special rules:

- **No personal entertainment devices with headphones may be worn.** Often we may offer an explanation that is intended for everyone in the class, or for a group. We should not be competing for your attention.
- **When you are asked to use a computer,** no program may be used in the lab other than those directly related to structural geology. Surfing the web or reading your email while the lab is in session is disrespectful to your instructor and TA, and is not an appropriate use of the resource.

Resources

Required Textbook: *Earth Structure* by Van der Pluijm and Marshak. (*Pluijm* is pronounced, roughly, *Plowm*),

This valuable text allows you to review all the main types of structure found in the Earth's lithosphere, and includes review material for the major topics covered in EAS 233. In addition, it contains a series of synthesis chapters on particular parts of the lithosphere, written by experts on those regions.

Recommended or Optional Learning Resources:

In addition to the text, you may also find that the laboratory manual for EAS 233 contains useful reference material.

Additional references and links will be posted during the course at

<http://courses.eas.ualberta.ca/eas421>

Note: For students who took EAS 233 in 2008 and earlier, there have been some changes to the content of this prerequisite course. The 2009/2010 course manual for EAS 233 contains summary sections on many of the major structures covered. Copies of this manual will be provided on request if you took EAS 233 in 2008 or before.

Representative Evaluative Material:

Because of overall changes in the content of EAS 421, previous exam papers do not provide a good guide to the material covered. Representative sample exam questions will be posted on the class web site during the first three weeks of the class, to indicate the type of question to be asked in the mid-term test. Sample final exam questions will be posted in October.

Evaluation and grading

Grade Evaluation:

Grade evaluation will be by a combination of relative standing in the class and absolute achievement. This means that grades will be assigned based on the overall quality of the work done so as to be consistent in standard with previous years' grading. No absolute grade distribution ('curve') will be imposed on the grades, but the overall level and range of grades is likely to be similar to other classes at this level at the University of Alberta.

Grades are unofficial until approved by the Department and/or Faculty offering the course.

COMPONENT	WEIGHTING	DATE
Midterm	20%	Oct. 20
Weekly Lab assignments	40%	
Final Exam*	40%	Dec 17

* WARNING: Students must verify this date on BearTracks when the Final Exam Schedule is posted

Format of Exams:

Exams will combine theoretical and practical aspects of the course, and will include a mixture of short-answer, longer written answer, and practical questions. Questions in the mid-term test will cover fundamental techniques; you will be asked to answer all the questions. The final exam will contain a mixture of practical and theoretical questions and will include both a compulsory section and a choice of questions.

Requirements for exams: Your student photo I.D. is required at exams to verify your identity. Students will not be allowed to begin an examination after it has been in progress for 30 minutes. Students must remain in the exam room until at least 30 minutes has elapsed. Electronic equipment other than calculators cannot be brought into examination rooms and hats should not be worn.

Bring to the exam room all the materials you normally bring to the labs. Before you enter the exam room, please ensure all textbooks, notes, and review materials are securely stowed inside a bag, and that you have unpacked all the pens, pencils, etc. that you plan to use. You are not permitted to look through your bag during the exam.

Missed Term Exams and Assignments:

A student who cannot write a term examination or complete a term assignment due to incapacitating illness, severe domestic affliction or other compelling reasons can apply for extension of time to complete an assignment or deferral of the midterm weight to the final examination. If you are in this situation at the time of a lab or examination, please be sure to contact your instructor within 48 hours of the missed class. I may require a statutory declaration of the circumstances. Please note that illness in the days before an exam is not normally considered to be grounds for deferral; don't leave your study to the last minute!

Deferral of term work is a privilege and not a right; there is no guarantee that a deferral will be granted. Misrepresentation of Facts to gain a deferral is a serious breach of the *Code of Student Behaviour*.

Deferred Final Examination:

A student who cannot write the final examination due to incapacitating illness, severe domestic affliction or other compelling reasons can apply for a deferred final examination. Such an application must be made to the student's Faculty office within 48 hours of the missed examination and must be supported by a Statutory Declaration (*in lieu* of a medical statement form) or other appropriate documentation (Calendar section 23.5.6). Deferred examinations are a privilege and not a right; there is no guarantee that a deferred examination will be granted. Misrepresentation of Facts to gain a deferred examination is a serious breach of the *Code of Student Behaviour*.

Reexamination:

A student who writes the final examination and fails the course may apply for a reexamination. Reexaminations are rarely granted in the Faculty of Science. These exams are governed by University (Calendar section 23.5.5) and Faculty of Science Regulations (Calendar section 182.5.9).

Misrepresentation of Facts to gain a reexamination is a serious breach of the *Code of Student Behaviour*.

Student Responsibilities:

Academic Integrity: 'The University of Alberta is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the *Code of Student Behaviour*, online at

www.ualberta.ca/secretariat/appeals.htm,

and avoid any behaviour which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.'

All forms of dishonesty are unacceptable at the University. Any offense will be reported to the Senior Associate Dean of Science who will determine the disciplinary action to be taken. Cheating, plagiarism and misrepresentation of facts are serious offenses. Anyone who engages in these practices will receive at minimum a grade of zero for the exam or paper in question and no opportunity will be given to replace the grade or redistribute the weights. As well, in the Faculty of Science the sanction for **cheating** on any examination will include **a disciplinary failing grade** (no exceptions) and senior students should expect a period of suspension or expulsion from the University of Alberta.

EAS 421 is a very practical course in which you may benefit from discussions with your instructor, teaching assistants, and fellow students in devising problem-solving strategies. However, the actual answers you record must be exclusively your own work. This means that:

- observations must be your own;
- written answers must be expressed in sentences and paragraphs ***composed uniquely in your own words***;
- every calculation and construction ***must be carried out by you***.

(In the event that you are explicitly instructed to work in groups on a problem, your answer must contain a written acknowledgement of the other participants.)

Cell phones: Cell phones are to be turned off during lectures, labs and seminars. Cell phones are not to be brought to exams.

Support

Students with disabilities: Students who require accommodation in this course due to a disability are advised to discuss their needs with Specialized Support & Disability Services (2-800 Students' Union Building).

Academic support centre: Students who require additional help in developing strategies for better time management, study skills or examination skills should contact the Academic Support Centre (2-703 Students' Union Building).

Legalities

Copyright: This documents, and other documents distributed during the course (except where otherwise stated), are copyright © Dr. John Waldron, Department of Earth and Atmospheric Sciences, Faculty of Science, University of Alberta (2010), and may not be sold or reproduced without permission.

Disclaimer: Any typographical errors in this Course Outline are subject to change and will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported in this syllabus.

Policy about course outlines can be found in section 23.4(2) of the University Calendar.

Tentative schedule of lectures and labs

	Lecture		Lab	
Sep-08 wed	Structural Geology and Tectonics			
Sep-10 Fri	Lines and planes			
Sep-13 Mon	Orientation data			
Sep-15 wed	Global tectonics: basics	Sep-16 Thu	Lab 1	Orientation data
Sep-17 Fri	Plate boundaries			
Sep-20 Mon	Plate kinematics	Sep-20 Mon	Lab 1	Orientation data
Sep-22 wed	Measuring plate motion	Sep-23 Thu		
Sep-24 Fri	Strain - longitudinal and shear strain			
Sep-27 Mon	Strain in 2D	Sep-27 Mon	Lab 2	Plate kinematics
Sep-29 wed	Measuring strain	Sep-30 Thu	Lab 2	Plate kinematics
Oct-01 Fri	3D and progressive strain			
Oct-04 Mon	Stress	Oct-04 Mon	Lab 3	Strain
Oct-06 wed	Stress calculations	Oct-07 Thu	Lab 3	Strain
Oct-08 Fri	Measuring stress			
Oct-11 Mon		Oct-11 Mon		
Oct-13 wed	Rheology: stress-strain relationships	Oct-14 Thu	Lab 4	Strain 2
Oct-15 Fri	Crystal defects and deformation			
Oct-18 Mon	Deformation mechanisms	Oct-18 Mon	Lab 4	Strain 2
Oct-20 wed	Mid-term test	Oct-21 Thu	Lab 5	Stress
Oct-22 Fri	Rifts			
Oct-25 Mon	Normal faults	Oct-25 Mon	Lab 5	Stress
Oct-27 wed	Orogens	Oct-28 Thu	Lab 6	Rifts
Oct-29 Fri	Subduction, accretion and mélange			
Nov-01 Mon	Foreland fold & thrust belts	Nov-01 Mon	Lab 6	Rifts
Nov-03 wed	Thrust kinematics	Nov-04 Thu	Lab 7	Thrust belts 1
Nov-05 Fri	Section balancing			
Nov-08 Mon	Basement and thrust dynamics	Nov-08 Mon	Lab 7	Thrust belts 1
Nov-10 wed	Slate belts	Nov-11 Thu		
Nov-12 Fri				
Nov-15 Mon	Polyphase metamorphic belts	Nov-15 Mon	Lab 8	Thrust belts 2
Nov-17 wed	Shear zones	Nov-18 Thu	Lab 8	Thrust belts 2
Nov-19 Fri	Pressure-temperature-time paths			
Nov-22 Mon	Alps	Nov-22 Mon	Lab 9	Polyphase deformation
Nov-24 wed	Terrane analysis	Nov-25 Thu	Lab 9	Polyphase deformation
Nov-26 Fri	Terrane examples			
Nov-29 Mon	Strike-slip tectonics	Nov-29 Mon	Lab 10	Strike-slip shear zones
Dec-01 wed	Transtension	Dec-02 Thu	Lab 10	Strike-slip shear zones
Dec-03 Fri	Transpression			
Dec-06 Mon	Impact structures			
Dec-08 wed	Review			
Dec-17 Fri	Final test			