University of Toronto-Scarborough
Department of Physical and Environmental Sciences
EESC37H3 Structural Geology - Fall 2019-2020

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Office hours: Monday 3.30 – 4.30 pm, EV466 or EV224, and by appointment
Teaching Assistant: **Graham Horrocks**

Lectures: **Tuesday, 10 am – 12 pm (Room HL B110)**
Labs: **Tuesday, 1 pm – 3 pm (Room IC 326)**

Overview:
Structural geology is the study of the deformation structures in Earth's lithosphere. Structures such as folds, faults, mineral fabrics, and the respective patterns occur at a variety of scales and led to changes in shape and geometry of rocks. Deformation description and various approaches in 'Structural analysis' will be covered in this course:

- Geometric analysis – analysis of the geometry (patterns, shapes and mineral fabrics) of primary structures acquired while the rock was being deposited or emplaced, and secondary structures produced by subsequent deformation
- Kinematic analysis – analysis of the displacement and movements that lead to shape changes (deformation = strain) of rock bodies
- Mechanical and dynamic analysis – reconstruction of forces (stress e.g. magnitude, direction, duration) that led to deformation within a rock body

These help to describe deformation structures, delineate deformation conditions, better understand deformation and processes such as plate tectonics.

Part of this course is a 2-day field trip to the Bancroft Area during which we will see various structures formed under different deformation conditions. This field trip will also allow us to practice hands-on skills such as rock ID, compass measurements, note taking, classification of deformation structures and interpretation of deformation processes.

Objectives of the course:
The objective of this course is to introduce students at a beginner to intermediate level to the fundamentals of structural geology and structural analysis. At the end of the course you can:

- use a compass to take structural geologic measurements
- construct and interpret geologic maps and cross sections
- describe and analyse geologic structures and infer related kinematics and dynamics
- explain the fundamentals of the mechanics of brittle and ductile deformation of rocks
- identify and interpret of geologic structures in the field
- infer rock forming and altering processes.
- use your spatial skills to interpret subsurface structures based on given geologic information

Overall, the course is expected to contribute to inferring deformation processes from observed geologic structures and to decipher the long processes based on the geologic record our planet holds. This bears not only on unravelling geodynamic processes, which have shaped the Earth's crust, but also on understanding the formation of the natural resource deposits.

Pedagogic Study – Evaluation of exercises for 3D skill training effects in Geoscience courses:
It is paramount that basic knowledge of Geology and 3D visualization/spatial skills training is integrated in courses of all levels. To evaluate efficiency of 3D skill training in EESC37 - Structural Geology, we are pursuing a pedagogic study. For this study we will integrate additional 3D skill learning and training opportunities in form of four specifically designed exercises (regular course participation).

You all are invited to participate by doing surveys (and possibly the interview), but none of you is required to do so. Additionally, you are able to withdraw your data at any time (also retroactively), in case you decide otherwise even after participating earlier.

For more information regarding the study and data collection, please see information posted by Sahar Gholzom (Research Assistant) on Quercus (announcements).

Readings:

Recommended text: **Structural Geology – 2nd Ed.,** 2016, H. **Fossen**, Cambridge Univ. Press

Needed (download): **An introduction to geologic structures and maps,** Bennison et al., Routledge, 8th edition, Free download through UTSC library - Online Course Reserve (quercus link).
Plate Tectonics – Continental Drift and Mountain Building, Frisch, Meschede and Blakey, 2011. Free download through UTSC library - Online Course Reserve (quercus link).

Additional downloads: **Structural Analysis and Synthesis: A laboratory course in Structural Geology,** Rowland, Duebendorfer, & Schiefelbein, Blackwell Publishing, 3rd Edition. (course reserve)

Lecture & Lab Schedule - Subject to change:

Week	Lecture Date	Lecture topic	Exercise	Lab Date	Lab Nr.	Lab	Homework	other
1	3.9.	**Lect. 1:** Intro + Survey + Stress + compass	compass measurements	3.9.		No Lab	No HW	Pre-course 3D skill survey
2	10.9.	**Lect.2 :** Strain	3D Stress/Strain (force-deformaiton, ellipsoids)	10.9.	**Lab 1**	Strain Analysis		
3	17.9.	**Lect. 3:** Strain & Stress	Mohr circles	17.9.	**Lab 2:** Intro to box models +3 point method	Ungraded: True - apparent dip, layer geometry	3 point problem	
4	24.9.	**Lect. 4:** Changes with depth, Brittle	Brittle Def.	24.9.	**lab 3**	Intro geol maps inclined beds	geol. Map. Inclined bed	Mid-course 3D skill survey
5	1.10.	**Lect. 5:** Stereonet + Fold Intro + Exercise	Stereo Exercise: planes , fold	1.10.	**lab 4**	Schmidt Net Projections (planes)	Schmidt Net Projections (planes)	
6	8.10.	**Lect. 6:** Ductile	Fold description, classification, geometry	8.10.	**lab 5**	geol. Map fault	geol. map & cross. section (fault)	
	12-15.10.	Reading week						

7	22.10.	Midterm during Lecture		22.10.	**lab 6**	Schmidt Net (folds), cross s. - maps		
8	29.10.	**Lect. 7:** Ductile (foliation, shear zones etc)		29.10.	**lab 7**	Folding\Schmidt Net, 1-2nd order, fold-poles etc		
Nov. 2-3, 2019 - Possible Field Trip Date: 2-Day field trip to Bancroft Region								
9	5.11.	**Lect. 8:** Def. Scales + compressional regime		5.11.	**lab 8**	Schmidt Net (rotation), stress directions, geo map include igneous r		
10	12.11.	**Lect. 9:** compressional regime	3D google earth exercise folds faults (tectonic processes - regional scale)	12.11.	**lab 9**	Shear Zones + SC fabrics (picture analysis)		
11	19.11.	**Lect. 10:** extensional regime	Post-course survey		**lab 10**	Analogue Model + finish map		
12	26.11.	Recap		26.11.	Lab exam			Field Trip Report Due: Dec. 1, 2019, midnight
13	3.12.	Study break						

Marking Scheme:

10 Lab assignments (each 3.5%)	35%
3 Online Quizzes (each 1 %)	3%
2-Day Field Trip (participation, report)	6%
In-class participation (exercises, i-clicker)	2%
Glossary work (2 entries + 2 edits)	2%
Midterm (in lab time)	22%
Final Exam (date to be announced)	30% (20% Theory + 10% Lab Exam)
Total	100%

Lectures and Lab exercises:

There will be one two-hour lecture and one two-hour lab period per week.

ALL students are expected to attend ALL lectures. ***It is the responsibility of the student to ensure that notes are obtained for any classes missed.***

The purpose of the weekly lab period is to demonstrate practical methods for analysis of structural data and interpretation of geologic maps. **Labs are mandatory (35% - In-lab or homework) for all students and the respective assignments are graded.** During lab you will have a chance to work more independently in order to strengthen your knowledge; during the lectures you'll receive more guidance throughout the material. **Lab assignments are to be completed in one week and submitted in the following week's lab.**

The knowledge acquired during the laboratory exercises can also be tested in the **3 Online Quizzes.**

Required lab materials:

- Protractor (drawing circles, measuring angles), calculator with trig function
- A drafting ruler (inches and centimeters), small scissors, pencils, eraser, color pencils
- **I will order graph paper (in millimeters) and tracing paper and hand out packages that should cover the amount we need in the labs and for practicing. Each package will be around 2-3 $.**
- A notebook/pad for practice (simple drafting paper, without lines or squares, is also very useful for this course)

2-Day Field Trip – Hastings County (Marmora, Burleigh Falls to Bancroft etc.) – Group Work:

This field trip is mandatory for all students. A fee for accommodation (approx. 60$) will arise, which we will keep as low as possible. Transportation costs are covered.

During the field trip groups of 2-3 students will look at the local rock formations, describe and ID these, 2% of the grade will be based on trip participation and 4% will be based on your written (group) field trip report. Deadline: TBA.

For more information on the field trip report see quercus -> files -> field trip assignment. An equivalent alternative assignment will be given if a student cannot participate during the field trip.

Furthermore, we are outdoors and therefore some preparations are needed:

- Be prepared for any kind of weather (sun vs. rain: rain jacket, sun screen, hat)
- Sturdy footwear (at least running shoes, preferably hiking boots) -> **NO open-toed shoes, sandals, or heels!!!**
- Adequate clothing (long pants, layers, rain cloth)
- Safety goggles or light tinted sun glasses
- Daypack with an adequate amount of water and lunch (+ smaller snack)
- If possible small camera, field book (e.g. small notebook), pencil & pen

Additional required safety equipment (e.g. hard hats, additional safety goggles) will be supplied by the department.

Additional information will be given in timely manner, as it is still unclear if it will be a 2-day trip (accommodation, equipment such as sleeping bag etc.)!

Field Trip Dates: Nov. 2-3, 2019 **Field Trip Fee: (approx. 60$)**

Online Quizzes – Individual Work:

Three online quizzes will be posted (see course schedule) and each quiz is 1 % (3% total) of final grade. Each quiz will consist of roughly 10-15 questions (multiple choice, True/False).

Quercus Glossary (2%):

Part of the course work is to create **four glossary posts (each 0.5%, total 2%)**. The glossary (make your own geodictionary) is hosted on quercus and will include the most important new terminology of the course. You can select **four terms** from the glossary list on quercus. Student contributions will be monitored by the TAs and instructor throughout and by the end of the term (grade based on quality of term definition – figure/diagram if applicable).

Two of the posts have to be finished by Wednesday October 18 (terms up to lecture 6), 2019 and the second two post by December 5, 2019!

Study Questions – Group or Individual Work:

I will post a set of study questions on each course topic, which should help you to identify the important course information, study for the quizzes and exams, prepare you for the field trip and to keep on top of the material.

Library Service:

Research Help: University of Toronto Scarborough Library

Staff at the UTSC Library will be happy to help you find the resources you need for your assignments, and learn the research skills you will need for success at university.

Research help is available by phone, e-mail, chat, or in-person in the Library.

For more information, please see the Library's Help Guide for UTSC Students: http://guides.library.utoronto.ca/utsc_help

Need in-depth or department specific assistance? Contact Sarah Forbes, Liaison Librarian for Physical and Environmental Sciences: http://uoft.me/smforbes

Quercus:

Lecture and lab material will be posted on and Online Quizzes will be done through quercus. Please check quercus and your email (UofT) daily for updates (e.g. assignments, announcements etc.). Quercus: q.utoronto.ca

Academic Integrity Statement:

Academic integrity is one of the cornerstones of the University of Toronto. It is critically and important both to maintain our community which honours the values of honesty, trust, respect, fairness and responsibility and to protect you, the students within this community, and the value of the degree towards which you are all working so diligently. According to Section B of the University of Toronto's Code of Behaviour on Academic Matters, which all students are expected to know and respect, it is an offence for students:

- to use someone else's **ideas or words** in their own work without acknowledging that those ideas/words are not their own with a citation and quotation marks, i.e. to commit plagiarism.
- to include false, misleading or concocted **citations** in their work.
- to obtain **unauthorized assistance** on any assignment.
- to provide **unauthorized assistance** to another student. This includes showing another student completed work.
- to submit their own work for credit in **more than one course** without the permission of the instructor.
- to falsify or alter any **documentation** required by the University. This includes, but is not limited to, doctor's notes.
- to use or possess an **unauthorized aid** in any test or exam.

There are other offences covered under the Code, but these are by far the most common. Please respect these rules and the values, which they protect. It is your responsibility to ensure that your work maintains academic integrity. If you have any concerns please see the instructor before a potential problem arises. Please familiarize yourself with the Code (http://www.governingcouncil.utoronto.ca/policies/behaveac.htm) and also with the handout "How not to plagiarize", available in the Course Documents section on BB. At the University of Toronto academic dishonesty can result in a *mark of zero, a reduction in final grades, denial of privileges, a monetary fine, failure in the course, suspension, permanent record, a recalling of degrees/diplomas and certificates, or expulsion.*

Accessibility Needs:

The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom or course materials, please contact Accessibility Services as soon as possible: UTSC campus AccessAbility http://www.utsc.utoronto.ca/~ability/ or St. George Campus Dis*Ability* *d*isability.services@utoronto.ca or http://studentlife.utoronto.ca/accessibility.