

# Structural Geology & Tectonics

Geology 4060, Spring 2023

4 credit hours

Course Syllabus

**Prerequisites:** GEO2500 & GEO 3100 (which includes PHYS2210, or PHYS2010 for ESCT majors)

**Lecture:** Tuesday & Thursday from 12:25 – 1:45 PM in Sutton 483

**Laboratory:** Tuesday from 2 – 5 PM in Sutton 375

**Instructor:** Pete Lippert (pronouns: he/him/his; you are welcome to call me Pete, Dr. Lippert, or Professor Lippert)

*email:* [pete.lippert@utah.edu](mailto:pete.lippert@utah.edu) (I will rarely answer email or Canvas messages between 4:30 PM and 9 AM, nor on the weekends). You can also message me *via* Canvas. Use communication with your instructors and TAs as opportunities to practice professional written communication as you would with a client or vendor.

*Office:* Sutton 325, can also meet *via* Zoom.

*Office Hours:* Monday 11 AM – 12 PM, Wednesday 10:30-11:30 AM, or by appointment (talk to me after class or email me).

## Teaching Assistants:

Kostas Gkogkas, Ph.D. Graduate Student

*email:* [kos.gkogkas@utah.edu](mailto:kos.gkogkas@utah.edu)

*Office Hours:* Monday and Wednesday from 1-2 PM in the Student EpiCenter (1<sup>st</sup> floor FASB). Note that Kostas will answer student emails between 9 AM and 5 PM.

## Textbook (strongly recommended)

*Structural Geology, 2<sup>nd</sup> Edition*, by Fossen (ISBN: 978-1-107-05765-7: this book has excellent online resources, too. I will provide links when relevant. The first edition of this book will also work, but the binding is terrible and it will break on you and there isn't as much content in it as in the second edition.

The bookstore has ordered a few copies; library should have a copy on reserve. This is one of the less expensive Structural Geology textbooks out there and has been around for a few years, so you should be able to find used copies, too.

## Additional Structural Geology Resources

1. *Structural Geology of Rocks & Regions, 3<sup>rd</sup> Edition*, by Davis, Reynolds, & Kluth (previous textbook for this course)
2. *Basic Methods of Structural Geology*, Marshak and Mitra
3. *Structural Geology, 1<sup>st</sup> or 2<sup>nd</sup> Edition* by Twiss and Moores
4. *Structural Geology*, by Fossen (this book has great online resources, too; 2<sup>nd</sup> Edition is best value)
5. *Earth Structure, 2<sup>nd</sup> Edition* by Van der Pluijm and Marshak
6. *Structural Geology, 3<sup>rd</sup> Edition* by Hatcher & Bailey
7. *The Techniques of Modern Structural Geology, Vol. 1&2* by Ramsay and Huber
8. *Microtectonics, 2<sup>nd</sup> Edition* by Passchier and Trouw

## Goals & Learning Objectives for Students

Structural geology concerns describing and quantifying **strain** (deformation) observed in rocks and relating that deformation to tectonic **stresses** (forces) in the past. In this course, you will learn to recognize and describe a wide variety of tectonic structures and interpret the geologic history of rocks and regions based on your **observations** and **measurements** at a variety of scales. Learning outcomes include:

1. To be able to recognize, describe, and analyze rock deformation from thin-section to regional scale. This includes the characterization of the composition and geometry of rock bodies in thin section, hand sample, outcrop, and from maps and remote sensing data (*e.g.*, lidar, seismic images...).
2. To be able to explain the fundamentals of stress, strain, and rheology and how they pertain to rock deformation. *e.g.*, the kinematics (motion) and dynamics (forces) of elastic and plastic deformation and the resulting faults and other fractures, folds, and rock fabrics.
3. To be able to relate rock deformation to plate tectonics.

By the end of this course, you should be able to apply your knowledge of mathematics, biology, chemistry, physics, material science, and geology—learned herein and from previous coursework—to articulate the fundamental principles of structural geology as they pertain to studying Earth processes and human interactions with these processes. You will achieve this by collecting, analyzing, and interpreting geological data in field, lab, and classroom settings.

## Structure of the Course

The course is based around two class periods and one lab per week. Attendance is expected at all class periods; class will entail unannounced quizzes and exercises and it is where homework assignments are distributed and returned. **Labs** are an integral, important, and rewarding part of this course; they include additional lecture material that is covered only briefly (or not at all) in regular lecture and provide hands-on experience with rocks, outcrops, and the tools of the well-trained geoscientist. Come mentally prepared to engage your mind for the full three hours (skipping lab or regularly skipping out early or arriving late is not acceptable). You have exclusive access to the TA's help and guidance during the lab period: make good use of that time. *Labs often require additional work outside of lab time; do not expect to always complete your labs within the allotted laboratory session.*

In addition to lectures and labs, the course will comprise **online quizzes** and **homework assignments** intended to augment and enrich the material covered in class and to help you retain material covered in your readings. Two types of homework assignments will be given: writing and problem set assignments, and daily reading assignments. All homework will focus on adding new dimensions to the material presented during lecture. Material from the homework assignments is part of the course and will be fair game on quizzes and examinations.

The course will also have **one mandatory one-day field trip** to be held on Saturday, April 1. The field trip will be to Antelope Island in the Great Salt Lake to look at structures introduced in class and to complete a graded field and mapping exercise.

## **Expected Classroom Behavior and Fostering a Diverse and Inclusive Learning Environment**

Ask questions. Be engaged. Please turn off ALL electronic devices, including laptops and smart phones unless instructed otherwise. Taking notes for this class comprises making annotated illustrations and writing equations, in addition to regular notes. *I provide handouts to guide your note taking.* You do not need your laptop or smartphone to take notes (but rather a notebook and pen; or tablets in note-taking mode) and using these devices during class is often very distracting to your peers and instructors. Do not disrupt the lecture in other ways, either, such as regularly arriving late, talking while someone else is talking, or displaying threatening or intimidating behavior toward your peers and instructors. Repeated offense will result in disciplinary action. For more information, please see: [www.hr.utah.edu/employeeRelations/Dealing-with-Disruptive-and-Threatening-Behavior.pdf](http://www.hr.utah.edu/employeeRelations/Dealing-with-Disruptive-and-Threatening-Behavior.pdf)

I reiterate the mission of the Office for Inclusive Excellence (<http://inclusive-excellence.utah.edu/>) whose mission is to ‘engage, support, and advance a living, learning, and working environment that fosters respect, diversity, equity, inclusivity, and academic excellence for students in our increasingly global campus community.’ We will ask all members of the class to participate in lecture and lab, which at times means you will need to explain ideas or concepts that you may not be particularly confident about initially. The success of this aspect of the class depends on developing a classroom environment in which everyone becomes more at ease taking intellectual risks, knowing that their questions and contributions will be respected. Do your part to foster that environment. If you feel you are being disrespected by your peers or the instructors, please bring this to my attention (or to a staff member in the office above if you are uncomfortable speaking to either the instructor or TA) so that it can be addressed immediately. Another great resource on campus is the cadre of student success coaches, who can help you navigate all sorts of communication and course challenges. See their website (<https://ssc.utah.edu>) for more information.

Harassment or violence based on sex, gender, race, national origin, color, religion, age, status as a person with a disability, veteran’s status, or genetic information will not be tolerated. If you or someone you know has been harassed or assaulted, you are encouraged to report this to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS).

The Department of Geology & Geophysics, as well as the American Geophysical Union, the largest professional organization of Earth and space scientists, have **professional codes of conduct** to set and maintain standards for the integrity of science and the scientific enterprise. You can read them here:

Univ. Utah Dept. of Geology & Geophysics (copy available on Canvas, too): <https://tinyurl.com/55fd4mj>

American Geophysical Union: <https://www.agu.org/Learn-About-AGU/About-AGU/Ethics>

## Assessment & Grading Policy

Concurrent enrollment in lecture and lab is required. Substantive assessment comprises **in class and online quizzes, homework assignments, two midterm examinations, a final examination**, and your **laboratory assignments**.

You will receive the same grade for both sections. The entire course is 4 credits. The course grade is based on the following weighting:

1. Quizzes	10%
2. Homework	15%
3. Laboratory Exercises	35%
4. Midterm 1	12.5%
5. Midterm 2	12.5%
6. Final Exam	15%

Final marks will be awarded based on the final percentage (calculated from the weightings above) and converted to a letter grade according to the following scale:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
100-90	89-88	87-86	85-81	80-79	78-76	75-70	69-60	59-58	57-53	52-51	<50

You will receive a **grade forecast** after your first and second midterm. This will let you know your standing in the course throughout the semester so that you can adjust your study habits as you see necessary. Note that the way grades are reported on Canvas is not always correct or is easy to misinterpret because of incomplete information: *your grade as reported on Canvas at any given time may not provide an accurate portrayal of your current standing in the course*. Ask Professor Pete Lippert if you have questions about your current grade.

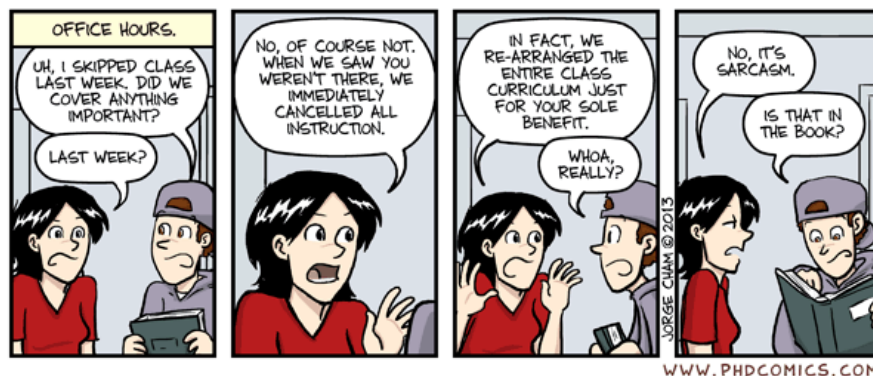
**Lateness Policy:** Lab exercises and homework assignments are due at the beginning of your lab section or the lecture at which they are due unless otherwise specifically stated by the instructors. Turning in the assignment at the end of lecture or lab results in the assignment being marked 1 day late. Your maximum possible score on the assignment will be discounted at a rate of 15% the first day late and 5% each successive day. The grade is calculated using  $G = G_0 * (1 - 0.15 - 0.05 * (t - 1))$ , where  $t$  is the number of *weekdays* late and  $G_0$  is your starting actual score. For example, if you earn 80% on your lab, but turn it in 3 days late, then your recorded grade is 60%. *Work that is more than one week late will not be accepted for credit (but will be assessed for understanding)*. If you have circumstances that prevent you from turning in an assignment on time, then you must notify either your TA (for lab) or Professor Pete Lippert (for everything else) *before* the assignment is due and make appropriate arrangements with us.

### Some, but not All Important Dates for GEO 4060 during Spring 2020:

1. Tuesday, January 10 – First day of SGT
2. Tuesday, January 10 – SGT Lab begins
3. Thursday, February 9 – *Tentative* date for **First Midterm**
4. Saturday – Sunday, March 4 – 12 – Spring Break – **no class**
5. Thursday, March 30 – *Tentative* date for **Second Midterm**
6. Saturday, April 1 – **Field Trip to Antelope Island**
7. Tuesday, April 25 – Last Class & Last day of classes
8. Wednesday, May 3 – **Final Exam** (10:30 – 12:30 am, FASB 483) (I may change this to the last day of classes)

**Absence Policies:** Lecture, lab, and field trip attendance is required for success in this course. All holiday or special events observed by organized religions will be honored for those students who have affiliation with that particular religion. If you must miss class or lab for another reason, please contact your instructors well in advance to see what make-up opportunities might be available. If you are sick or starting to feel unwell, please give yourself the space to get rested and healthy and protect your peers from also getting sick. Please let your instructors know as soon as possible that you will be missing class or lab so that we make arrangements to keep you engaged in the course.

University Policy states (PPM, Policy 6-100III-O): "The University expects regular attendance at all class meetings. Instructors must communicate any particular attendance requirements of the course to students in writing on or before the first class meeting. Students are responsible for acquainting themselves with and satisfying the entire range of academic objectives and requirements as defined by the instructor."



**Academic Integrity (i.e. cheating and plagiarism):** Structural geology is a challenging class and we fully expect (and encourage) students to share their thoughts about problems and concepts. However, we also fully expect that solutions and work with your name on it ultimately reflect your own careful thought, wording, and illustration. Cheating is any attempt to represent someone else's work (on exams, homework, labs...you get the idea) as your own. You are expected to follow all University policies regarding academic integrity, including any form of cheating, plagiarism, and fabrication. The TA and I have zero tolerance for cheating. Cheating can (and often does) result in a failing grade for this course, and it may even lead to additional university discipline. **RESPECT YOURSELF AND YOUR COLLEGE DEGREE: DO NOT CHEAT!** Do not plagiarize. For further details, please refer to the University's Policy and Procedures Manual: <http://regulations.utah.edu/academics/6-400.php>

**ADA Americans with Disabilities Act:** The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this course, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability & Access. Please contact me at the **beginning** of the semester to discuss accommodations for this course.

**University Safety Statement:** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-2677(COPS). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit [safeu.utah.edu](http://safeu.utah.edu).

**Addressing Sexual Misconduct:** Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity and expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS). If you are not comfortable contacting these offices on your own or would like support, please see me, your TA, or department staff, and one of us can help you contact them.

**Student Names & Personal Pronouns:** Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account). While CIS refers to this as merely a preference, we will honor you by referring to you with the name and pronoun that is best for you in class, on papers, exams, group projects, *etc.* Please advise us of any name or pronoun changes (and update CIS) so we can create a learning environment in which you, your name, and your pronoun is respected. If you need assistance getting your preferred name on your UIDcard, please visit the LGBT Resource Center Room 409 in the Olpin Union Building, or email [bpeacock@sa.utah.edu](mailto:bpeacock@sa.utah.edu) to schedule a time to drop by. The LGBT Resource Center hours are M-F 8 AM-5 PM, and 8 AM-6 PM on Tuesdays.

**Wellness:** Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, *etc.*, can interfere with a student's ability to succeed and thrive at the University of Utah. For resources contact the Center for Student Wellness at [www.wellness.utah.edu](http://www.wellness.utah.edu) or 801-581-7776.

**Veterans:** If you are a student veteran, the U of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5pm. Please visit their website for more information about what support offered, a list of ongoing events and links to outside resources: <http://veteranscenter.utah.edu>. Please also let me know if you need any additional support in this class for any reason.

**Learners of English as an Additional/Second Language:** If you are an English language learner, or want more practice improving your English language skills, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center (<http://writingcenter.utah.edu>); the Writing Program (<http://writing-program.utah.edu>); the English Language Institute (<http://continue.utah.edu/eli>).

**Undocumented Student Support:** Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit [dream.utah.edu](http://dream.utah.edu).

**COVID-19 Statement:** The University of Utah has implemented reasonable health and safety protocols, taking into account recommendations by local, state and national public health authorities, in response to the COVID-19 pandemic. For the most up-to-date information on COVID-19 protocol, please refer to <https://coronavirus.utah.edu>. Other resources include 1) [Student Guidance: What Steps to Take for a Possible or Confirmed COVID-19 Exposure](#) 2) [Registrar's Office COVID-19 Information and FAQ's](#) 3) [Housing & Residential Education](#)

**Please also refer to the College of Mines & Earth Sciences Guidelines for additional information about:**

- Additional health, counseling, and student support services
- Adding, withdrawing, and repeating courses
- Appealing grades and other academic actions
- Academic advisors

On Canvas and available at: <https://www.cmes.utah.edu/semester-guidelines>

**This syllabus is meant to serve as an outline and guide for our course. Please note that I may modify it with reasonable notice to you. I may also modify the Course Schedule to accommodate the needs of our class. Any changes will be announced in class and posted on Canvas under Announcements.**

## **Required Materials for Class and Lab**

You will be required to make a variety of illustrations and solve algebraic equations in class and lab.

*For each lecture, please bring:*

- fine mechanical pencils for drafting and sketching
- a good eraser
- a calculator
- your notebook and favorite writing implement (of course!)

*In addition to these items, please bring the following to each lab:*

- a set of colored pencils (minimum of 12 colors)
- ruler
- protractor
- drafting compass
- tracing paper

*Information contained in this syllabus, other than the grading policy, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor. Any changes will be announced in class and on Canvas.*



## GEO4060 - S2023 - Structural Geology & Tectonics

### Tentative Schedule

Date	Topic	Reading	Lab & Department Seminar
<b>Week 1</b>			
10-Jan	Welcome to SGT	F 1-4; NSF 1-7	Measurement of Planes & Lines
12-Jan	What is Plate Tectonics & Structure	NSF 9-16	
<b>Week 2</b>			
17-Jan	Primary Structures	DRK 706-711 (on Canvas)	Introduction to Stereonets
19-Jan	Secondary Structures & Structural Analysis	F4-22	
<b>Week 3</b>			
24-Jan	Joints 1	F123-129; 134-140; 153-168	More Stereonets
26-Jan	Joints 2	F123-129; 134-140; 153-168	
<b>Week 4</b>			
31-Jan	Introduction to Faults	F177-216	Joints
2-Feb	Key features of faults	F177-216	
<b>Week 5</b>			
7-Feb	Fault Slip Characterization	F221-234	Fault Slip
9-Feb	Frictional-Brittle Fault Rocks	F185-186, F221-232; Wise et al. (Geology 1984); NSF 29-28	
<b>Week 6</b>			
14-Feb	Review/Catch-Up	n/a	Fault Slip 2
16-Feb	<b>Midterm 1</b>	n/a	
<b>Week 7</b>			
21-Feb	Faults and Stress in the Lithosphere 1	F83-99	Evolution of Normal Faults
23-Feb	Faults and Stress in the Lithosphere 2	F83-99	
<b>Week 8</b>			
28-Feb	Introduction to Folds	F257-279	Rule of Vs & More Geological Maps
2-Mar	Geometrical Analysis of Folds	F257-279	
<b>Week 9</b>			
7-Mar	<b>Spring Break - no class</b>		<b>no lab</b>
9-Mar	<b>Spring Break - no class</b>		
<b>Week 10</b>			
14-Mar	Fold Mechanisms & Processes	F257-279	Map History
16-Mar	Map Patterns of Folds & Faults	tba	
<b>Week 11</b>			
21-Mar	Introduction to Cleavages	F283-298	Folds
23-Mar	Cleavages 2	F283-298	
<b>Week 12</b>			
28-Mar	Review/Catch-Up	n/a	Folds & Cleavages
30-Mar	<b>Midterm 2</b>	n/a	
1-Apr	<b>Field Trip Antelope Island</b>		
<b>Week 13</b>			
4-Apr	Stress 1	F73-81	Plastic Fabrics
6-Apr	Stress 2	F73-81	
<b>Week 14</b>			
11-Apr	Strain 1	F25-71	Stress 1
13-Apr	Strain 2	F25-71	
<b>Week 15</b>			
18-Apr	Rheology & Rock Strength 1	F101-120, F235-248	Stress & Mechanical Paradoxes of Faulting
20-Apr	Rheology & Rock Strength 2	F101-120, F235-248	
<b>Week 16 &amp; Beyond</b>			
25-Apr	Last Day of Class: Wrapping it all up	NSF 1-7	
3-May	<b>Final Exam : may move to a different day, but this is the university designated day and time</b>		