SIO 162
Structural Geology

Instructor Info

Dr. Vashan Wright

Office Hrs: Tue 1:30-2:30p

Munk 331

stripplelab.ucsd.edu

vwright@ucsd.edu

Course Info

Prereq: SIO 100 (Field Methods) or permission from the professor

Mon & Wed

10a-11:20a

Eckart 127

Lab Info

Fri

1p-3:50p

Vaughan 147

Lab Instuctor Info

Richard Kilburn

Office Hrs: Mon 3:00-4:00p

Munk 317C

Course Description

Structural geology is the study of how and why rocks change position and shape (i.e., deform). Structures, defined as the geometric configuration or arrangement of rocks, form when rocks and sediments are compressed, stretched, twisted, or otherwise displaced due to external forces (e.g., pressures related to the motion of tectonic plates). Structures may be big, such as folds in mountain belts, and small, such as repeated geometric arrangements of atoms. Structural geologists use structures to investigate the causes, timing, and implications of rock deformation events. The period of deformation events can range from 1000s of years, like with mountain building, to 10s of seconds, like with earthquakes.

This class will introduce students to concepts and terminology structural geologists use to analyze detectable structures within rocks and sediments. Students will learn the skills necessary to identify and quantify deformation structures and to communicate their observations and interpretations to other geoscientists. Students will develop an understanding of the physics that governs deformation, allowing them to interpret the structures they identify. Students will learn how to apply their newly developed structural geology skill sets to real-world problems.

Structural geology is a commonly taught undergraduate Earth science course. The materials that the professor will present will be sourced from structural geology textbooks, his understanding of the subject from years of doing structural geology research, data from his research, Kevin Brown's (former Scripps structural geology professor) lecture notes, James Kirkpatrick's (McGill University professor) lecture and lab notes, and existing photos of structures that the professor finds online.

Learning Objectives

At the completion of this course, students should be able to:

1. Understand the basic principles of rock deformation.
2. Describe rock deformation structures.
3. Interpret the deformation history of rocks from deformation structures.
4. Develop and test geologic models of deformation structures in space and time.

Course Material

Required Texts

Fossen, H. (2016). Structural geology. Cambridge University Press. [A copy of this text is on Canvas.]

Additional Resource

Summaries of each chapter (E-modules) on the author's website:
https://folk.uib.no/nglhe/StructuralGeoBookEmodules2ndEd.html

Other

The textbook *Processes in Structural Geology and Tectonics* by Ben van der Pluijm and Stephen Marshak is a nice complement to the textbook by Fossen (2016). The textbook by Pluijm and Marshak is free and available online here:
http://psgt.earth.lsa.umich.edu/. Students will need to email the authors for access to this textbook.

Any required journal articles and book chapters will be provided on Canvas.

FAQs

What is the policy on turning in late or missed work?

Make-up exams or assignments will only be allowed for students who have a substantiated excuse approved by the instructor *before the due date*. Leaving a phone message or sending an e-mail without confirmation is not acceptable. Labs are mandatory. You are still responsible for completing the lab assignment if you miss a lab period.

Are the field trips mandatory?

Yes.

What type of structural geology do you (the professor) do?

The professor studies the deformation of fault zones in underwater environments using seismic-reflection profiles and sediment cores mostly.

Are there opportunities to work in research in your lab?

If you're interested in conducting undergraduate research, please discuss this with the professor during his office hours.

Course Context

This classroom will be a place where students will be treated with respect. The professor will strive to create a welcoming environment for students of all ages, backgrounds, beliefs, ethnicities, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, abilities, and other visible and non-visible differences. All class members are expected to contribute to a respectful, welcoming, and inclusive environment for every other class member.

The professor's goal is to support and stimulate effective learning. This includes teaching in ways that are inclusive and accessible to all students. If a student has any situation that affects their ability to benefit from the material offered in the course, that student can request reasonable accommodations. Please inform the professor as soon as possible and contact the Office for Students with Disabilities (https://students.ucsd.edu/well-being/disability-services/) for additional support.

All learning happens within cultural contexts. UC San Diego is located on the unceded traditional and sacred land of the Kumeyaay people, who still occupy this land and whose history, language, culture, and traditional ways of life continue to influence the greater San Diego community. Thus, the professor acknowledges that our class, life, and work occur on the unceded territory of the Kumeyaay nation, to whom we owe honor and gratitude. The professor's research and work also acknowledge the Taino people who lived on the Jamaican island territory and from which the professor recognizes part of his ascendancy and to whose elders the professor respects through his research and actions.

Grading Scheme

Students will receive a letter grade for the work they do in class. Grades will follow the following scale: A = 93-100; A- = 90-92; B+ = 87-89; B = 83-86; B- = 80-82; C+ = 77-79; C = 73-76; C- = 70-72; D+ = 67-69; D = 63-66; D- = 60-62; F <60. The professor will round up students' final grades to the nearest whole number — e.g., a 79.2 will be rounded up to an 80. Curving is at the discretion of the professor.

Grades in the C range represent performance that meets expectations; Grades in the B range represent performance that is substantially better than the expectations; Grades in the A range represent work that is excellent.

Grades are weighted as follows:

10%	Quizzes and In-class Exercises
15%	Class Project
15%	Midterm Exam
25%	Final Exam
35%	Lab

Lectures

On most class days, the professor will facilitate at least one active learning exercise at the beginning of class to pique interest in the topic, get students thinking, and determine what students already know. Lectures and open discussions will follow this. Students should expect to do algebra and trigonometry problems. Electronic note recording may be important for class, so computers are allowed. Eating and drinking are allowed in class.

Field Trip & Research Project

There is one mandatory field trip for this course. The field trip is where you will collect data for the class project. Please see the class schedule (last page) for the field trip date. If changes are needed, we will discuss them ahead of time.

Remote Learning

This course may include a mix of in-class and remote learning. Remote learning can be awkward. Even though the professor and students are mostly experts by now, we should still expect glitches and issues. The professor will work hard to make students' learning experience as smooth and enjoyable as possible. This course's content and evaluation scheme may change due to extraordinary circumstances beyond the University's or professor's control.

Attendance

Attendance is expected at all lectures. Valid excuses for absence will be accepted before class. In extenuating circumstances, valid excuses with proof will be accepted after class. Students are allowed to miss two unexcused classes during the quarter without penalty. Any further absences will result in grade deductions (1 point per missed class, taken from the total of the quiz scores).

How to do well in this course

The professors suggest that students attend all the lectures, labs, and exams. If students do this, pay keen attention in class, read for the quizzes, do most of the labs during lab time, and complete the assignments on time, they will have a better chance of doing well. Students should take good notes in class since the notes will be needed to revise for exams. Students are responsible for lectures, lab materials, and assigned reading. The professor will draw exam questions from these materials. Students should feel free to ask questions anytime – during the lectures, labs, or professor's office hours. Students may email the professor to make an appointment if visiting during office hours does not work for them. To achieve the best grades in the class, students will likely need to do the required reading, read around the subject for themselves, and demonstrate the knowledge gained from this study time by using it to answer the exam, quiz, and lab questions.

Academic Integrity and Honesty

Students are expected to complete the course in compliance with the highest standards of academic integrity. An honest effort is expected of everyone. By continuing enrollment in this course, students pledge to abide by UC San Diego's Integrity of Scholarship Agreement (https://academicintegrity.ucsd.edu/forms/form-scholarship-agreement.html), which reads as follows (some modifications were made to adjust it to the present course):

1. No student shall knowingly procure, provide, or accept any materials that contain questions or answers to any examination or assignment to be given at a subsequent time.
2. No student shall complete, in part or in total, any examination or assignment for another person.
3. No student shall knowingly allow any examination or assignment to be completed, in part or in total, for themselves by another person.
4. No student shall plagiarize or copy another person's work and submit it as the student's own work.
5. No student shall employ aids excluded by the instructor in undertaking course work.
6. No student shall alter graded class assignments or examinations and then resubmit them for regrading.
7. No student shall submit substantially the same material in more than one course without prior authorization. A student acting in the capacity of an instructional assistant (IA), including but not limited to teaching assistants, readers, and tutors, has a special responsibility to safeguard the integrity of the scholarship. In these roles, the student functions as an apprentice instructor under the tutelage of the responsible instructor. An IA shall equitably grade student work in the manner agreed upon with the course instructor. An IA shall not make any unauthorized material related to tests, exams, homework, etc., available to any student.
8. No student shall provide their assignments, in part or in total, to any other student in current or future classes of this course. No student shall procure or accept assignments from any other student from current or prior classes of this course.
9. For all group assignments, each group member is responsible for the academic integrity of the entire submission.
10. Each student is responsible for knowing and abiding by UCSD's Policies on Integrity of Scholarship and Student Conduct (https://students.ucsd.edu/sponsor/student-conduct/).
11. Any student violating these policies will earn an 'F' in the course and will be reported to the University for the violation.

Tentative Class Schedule

The course begins with the fundamentals of deformation, followed by examining ductile and brittle deformation structures, and then plate tectonics. The professor hopes to end the course by bringing everything together in the last week. The topics that the professor covers weekly might change depending on the class' progress.

Quiz and Suggested Reading Schedule

There will be a 10-minute quiz or in-class group exercise on the prior week's material during the Wednesday class for weeks 2-10 unless otherwise stated. The professor suggests reading the textbook's online E-module before lectures and reading the textbook chapter after attending lectures. This should prepare students well for the quiz/in-class exercise while enhancing the assimilation of the knowledge gained in class.

MODULE 1: Fundamentals of Deformation

Week 1	Introduction to Structural Geology	Chapter 1
	Introduction to Deformation	Chapter 2
Week 2	Fundamentals of Strain	Chapter 3
	Strain in Rocks	Chapter 3
Week 3	Introduction to Stress	Chapter 4
	Stress in Rocks	Chapter 5
Week 4	Rheology	Chapter 6

MODULE 2: Deformation Structures

Week 4	Shear Zones	Chapter 16
Week 5	Ductile Structures	Chapter 13-15
	Folds	Chapter 12
Week 6	EXAM	Chapters 1-6, 13-15, 16
	Mechanics of Folding	Chapter 12
Week 7	Brittle Deformation	Chapter 7
	Faults and Faulting Mechanisms	Chapter 9; Field trip: Feb 22

MODULE 3: Tectonics

Week 8	Reverse Faults	Chapter 17
	Extensional Faults	Chapter 18
Week 9	Transform Faults	Chapter 19
	Convergent Boundaries	
Week 10	Divergent and Transform Boundaries	
	Plate Tectonics and Natural Hazards	
Week 11	FINAL EXAM	March 21, 2025; 8-11 am; Eckart 127

A Note on Food Support for Students

If you are skipping and stretching meals or having difficulties affording or accessing food, you may be eligible for CalFresh, California's Supplemental Nutrition Assistance Program, which can provide up to $292 a month in free money on a debit card to buy food. Students can apply at benefitscal.com/r/ucsandiegocalfresh. If you're an international student, please check with the international student office to see if applying to such a program could impact your visa status now or in the future.

The Hub Basic Needs Center empowers all students by connecting them to resources for food, stable housing, and financial literacy. Visit their site at basicneeds.ucsd.edu

SIO 162
Structural Geology

Lab Instructor

Richard Kilburn

Office Hrs: Mon 3:00-4:00p

Munk 317C

rkilburn@ucsd.edu

Lab Info

Fri

1p-3:50p

Vaughan 147

Lab Section Description

The purpose of the SIO 162 lab section is to provide hands-on exposure to deformation structures and examples of problems requiring students to decipher the geologic processes that create deformation structures. Lab sections will focus on learning and practicing the scientific method applied to the covered topics and in geologic research in general. Students will not be expected to perfect each lab assignment. Still, they will be expected to critically engage with the material, theory, and process while advancing their practical knowledge of the concepts taught in this course.

Learning Objectives

At the completion of the lab section of this course, students should be able to:

1. Use the scientific method to answer questions in structural geology
2. Work independently and in small groups to examine deformation structures
3. Present findings and research process in an academic style
4. Use newly acquired skills in future courses and research

Grading Scheme

Students will receive a grade for the weekly assignments they do in the lab section, which equals 35% of the total course grade. Weekly lab assignments are due before the start of the next lab, but are designed to be completed during the lab session.

Grades for the Lab section are weighted as follows:

20%	Participation
80%	Weekly in-lab assignments

Lab Etiquette

Be ready to participate actively in each lab. The format of labs will vary as a function of the topic covered. Electronic note recording may be important for lab assignments, so computers are allowed in class. Eating and drinking are allowed in the lab. Any concerns about the lab format, including accessibility concerns, can be brought to Jhardel Dasent or Prof. Vashan Wright. A sincere effort will be made to create and support a positive and effective learning environment. Lab assignments can be completed outside the lab hours if desired, or extra time is needed.

Attendance

Attendance is expected at all labs. Valid excuses for absence will be accepted before class. In extenuating circumstances, valid excuses with proof will be accepted after lab. Any unexcused absences will result in grade deductions from the lab participation grade and associated lab assignments if not completed.

Questions & Further Assistance

The lab instructor will be available during office hours to answer questions about the lab, course, quizzes, or other academic life and research questions.

Lab Schedule

Week 1	Attitudes of planes and lines	Introduction to deformation, strike and dip measurement, and various types of structural analyses
Week 2	Measuring strain	Quantify the deformation of rocks using indicators of deformation and types of stress
Week 3	Mohr's circles	Assess the forces involved in deforming the Earth's crust
Week 4	Rheology of cake	Exploring the relationships between stress and strain – when a rock is under stress, how does it deform?
Week 5	EXAM	Review session to prepare for the in-class exam, no lab topic or assignment
Week 6	Shear zones	Structures that form in rocks during ductile deformation
Week 7	Three-point problems	Three-dimensional geometry of deformation structures and brittle deformation
Week 8	Stereonet problems	Introduction to stereonets and their uses
Week 9	Sandbox experiments	Real-time observation of tectonic forces, deformation, and structures with a sandbox
Week 10	Cross-section balancing	Observations and concepts in 2D to 3D and back again and the temporal order of structural events