

LEHIGH UNIVERSITY

CRN 11045

Spring 2021

EES 223-010

STRUCTURAL GEOLOGY & TECTONICS

Lecture: Tuesday and Thursday, 10:45AM-12:00PM, ST131, Synchronous, recorded then Posted

Zoom link: <https://lehigh.zoom.us/j/99060666268>

Laboratory: Monday, 1:35PM-4:15PM, Asynchronous, except lab 1, Pre-posted

Professor: Dave Anastasio

Email: dja2@lehigh.edu

Office Hours: Thursdays 1:30-2:30 PM, or make an appointment

Zoom link: <https://lehigh.zoom.us/j/94721269158>

Teaching Assistant: James Fisher

Email: jaf319@lehigh.edu

Office Hours:, Mondays 10:30-11:30AM, or an appointment

Zoom link: <https://lehigh.zoom.us/j/93156951688>

Required Textbook: Ben van der Pluijm, Steve Marshak. 2020. *Processes in Structural Geology and Tectonics* 2020. (v. 3.0). Students receive free access by emailing to procsgr@gmail.com (see website link).

Find answers to common questions on the FAQ

page: <https://psgt.earth.lsa.umich.edu/0/faq.html>

Plentiful handouts/Powerpoints will come from other sources. I will not lecture directly from any book.

Course Description: *Structural Geology and Tectonics* is a foundation discipline for the Earth and Environmental Sciences and a prerequisite for geology field camps, Professional Geologist licensing, and employment in geoscience fields. Structural Geology concerns itself with the *Geometry* or architecture of Earth structures, the *Kinematics* or deformation history of the lithosphere and the *Dynamics* or stress, strain, strain rate behavior of natural deformations from landslides and flowing glaciers to entire mountain ranges. *Tectonics* provides the context or boundary conditions for the structures, the driving forces, and the large-scale framework for lithospheric deformation. Structural analysis plays an integral role in understanding fluid flow essential for groundwater development, petroleum exploration, and ore deposit prospecting. Rock deformation also generates natural hazards such as earthquakes and volcanoes, which have dramatic societal impact, for example, the 2011 earthquake and tsunami in Japan that killed 15,883 and the meltdown of the Fukushima Daiichi nuclear power plant, the 2010 Haiti earthquake killed 222,570, the Shensi, China earthquake of 1556 that killed 830,000 people and the 2005 tsunami from a Sumatra earthquake that killed 227,898 people around the Indian Ocean, the 3rd most energetic earthquake ever recorded (9.1M). In this course, we will study the theoretical framework of rock deformation, the geometry and tectonic

context of crustal structures like folds and faults, rock textures and rheology, the geology and geophysics of modern plate boundaries and the geologic record of ancient plate tectonics.

Learning Objectives: Activities in EES 223 will provide an opportunity to achieve learning goals that go beyond the course's content objectives. Laboratories will provide you the opportunity to learn techniques to analyze natural structure. You will develop robust problem solving skills. You will be required to use the language of our discipline and to advance our science by building on prior knowledge.

Laboratories: The lecture and lab portions of this course are an integrated package. In addition to supporting lectures, course laboratories will introduce orientation analysis and geologic map analysis to continue your training as a geologist. Laboratory exercises are due by noon on Mondays the week after the exercise was assigned, unless otherwise noted on the assignment. Late laboratories require my signature before the TA will accept them.

Course Schedule

wk 1

2/2 Forces, Stress

lab 1 Course Introduction, Primary Structures, SYNCHRONOUS, everyone attends Zoom.

4 Stress

wk2

9 Mohr Circle for stress

lab 2 Planes, Lines, 3-point, and Complete the Outcrop Problems

11 Deformation and Strain

12 LAST DAY TO ADD WITH INSTRUCTOR PERMISSION

wk3

16 Problem Set 1 (4 lectures, 1 lab) posted.
Kinematics

lab 3 Strain Measurement

18 Material Properties and Rock Rheology

19 LAST DAY TO SELECT/CANCEL PASS/FAIL OPTION

wk4

23 Problem Set 1 due by 5PM

Deformation Mechanisms, Diffusion Mass Transfer, Microstructures,

lab 4 Stereonets 1

25 Crystal Plastic Deformation and Recovery

wk5

3/2 Problem Set 2 (4 lectures, 2 labs) posted.
Fractures Dikes, Joints

lab 5 Fracture Mechanics and Faulting
4 Veins

wk6

9 Problem Set 2 due by 5PM
Fault Separation and Slip, Normal Faults

lab 6 Geologic Maps

11 Strike-Slip Faults

12 Seminar Chris Marone, Title, TBD, Penn State Experimental Geophysics,
<https://lehigh.zoom.us/j/96376671868>

wk7

16 No Class.
Problem Set 3 (4 lectures 2 labs) posted

lab 7 Cross sections

18 Thrust Faults and Thrust Belts

19 John Jaeger, U. of Florida, Title, "Building Mountains in an Icy World"
<https://lehigh.zoom.us/j/96414169418>

wk8

23 Problem Set 3 due by 5PM

Fold Geometry

lab 8 No lab

25 Fold Kinematics Fault Related Folds

26 Seminar Assignment Due 5PM

wk9

30 Fold Mechanics

lab 9 Sheep Mountain Exercise

4/1 Tectonites, Shear Sense Indicators

wk10

6 Earth Structure, Plate Boundaries

lab 10 Orientation Analysis–Stereonet II

8 Problem Set 4 (4 lectures, 2 labs)
Divergent Boundaries

wk11

13 Passive Margins, Salt Tectonics

12 *lab 11 Plate Game I*

15 Problem Set 4 due by 5PM

Basin and Range / Metamorphic Core Complexes

16 LAST DAY TO DROP WITH A "W"

wk12

20 Convergent Boundaries, Orogenic Structure

lab 12 Plate Game II

22 Accretionary Tectonics

wk13

27 Problem Set 5 (4 lectures, 0 labs)

Oroclines, Non-rotational Arcs

lab 13 TBA

29 Plate Circuits

30 Plate Game Laboratory due by 5PM

LAST DAY FOR IN-CLASS EXAMS

wk14

5/4 Triple Junction Stability

Lab 14 Maryland fieldtrip via Google Earth

6 Problem Set 5 due by 5PM

Final Review

7 Last Day of Class, Undergraduate Research Symposium, undergraduate awards, TA award

EES223 FINAL EXAM DUE BY NOON, MAY 16, 2021, MIDNIGHT

FINAL EXAMS MAY 11-19, 2021

GRADES DUE MAY 21, 2021

Equipment you must provide:

Hard pencils 3H-5H, few colored pencils, erasers

Protractor, transparent

Engineering/scaled ruler

Drawing Compass

Course Evaluation:

Problem Sets: 5 at 10% each 50%, 1 week to do problem sets

Laboratory Exercises Total: 25% (10 weeks @2% each, labs 11-12@5%)

Seminar review 5%

Take Home Final 20%

Course Rules:

Labs are due by noon on subsequent Mondays, otherwise indicated; late labs will not be accepted without professor's approval.

Academic Honesty: It is the duty and obligation of students to meet and uphold the highest principles and values of personal, moral and ethical conduct. As partners in our educational community, both students and faculty share the responsibility for promoting and helping to ensure an environment of academic integrity. As such, each student is expected to complete all academic course work in accordance to the standards set forth by the faculty and in compliance with the University's Code of Conduct.

Accommodations for Students with Disabilities: Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at <https://studentaffairs.lehigh.edu/disabilities>.

The Principles of Our Equitable Community: Lehigh University endorses The Principles of Our Equitable Community. Lehigh University is committed to diversity, inclusion and engagement [<http://www.lehigh.edu/diversity>]. That commitment is captured in The Principles of Our Equitable Community. We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.