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 procsqt@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
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<th>wk11</th>
<th>13</th>
<th>Passive Margins, Salt Tectonics</th>
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<tr>
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<td>12</td>
<td><em>lab 11 Plate Game I</em></td>
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<td>15</td>
<td><strong>Problem Set 4 due by 5PM</strong></td>
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<td>Basin and Range / Metamorphic Core Complexes</td>
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<td>16</td>
<td>LAST DAY TO DROP WITH A “W”</td>
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| wk12 | 20 | Convergent Boundaries, Orogenic Structure |
|      |    | *lab 12 Plate Game II*          |
|      | 22 | Accretionary Tectonics         |

| wk13 | 27 | Problem Set 5 (4 lectures, 0 labs) Orogenic Structure, 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.