

*Department of Earth & Environmental Sciences*  
**LEHIGH UNIVERSITY**

**CRN 13331**

**Spring 2013**

**EES 223-010**

**STRUCTURAL GEOLOGY & TECTONICS**

**Lecture:** Tuesday and Thursday, 10:45AM-12:00PM, ST131

**Laboratory:** Monday, 1:10-4:00PM, ST131

**Professor:** Dave Anastasio

Office: ST 226, phone: x85117, Email: [dja2@lehigh.edu](mailto:dja2@lehigh.edu), (check my lab room 225 if I am not in my office)

Office Hours: Tuesday 9:00-10:00AM, Friday 10:30-11:30 AM or contact me for an appointment, or just stop by.

**Teaching Assistant:** Kellen Gunderson

Office: 591, phone: (610) 758-1243, Email: [kellen.gunderson@lehigh.edu](mailto:kellen.gunderson@lehigh.edu)

Office Hours: Monday 9:00-11:00 AM and Wednesday, 2:00-3:00 PM or by appointment.

**Textbook:** A modern Structural Geology textbook is recommended. I have asked the Lehigh bookstore to stock Structural Geology of Rocks and Regions, 3<sup>rd</sup> edition by Davis, Reynolds, and Kluth 2012, 864pp, ISBN:0-471-15231-5, 978-0-471-15231-6, 1-118-21586-9, 978-1-118-21586-9. The book is available from the publisher, John Wiley and Sons as an eTextbook for \$49.50, and it is available in hardback from Amazon to buy for \$77.20 or \$47.81 to rent. Other suitable books may be available used on Amazon offering substantial savings. I will discuss textbooks the first day in lab.

**Course Description:**

*Structural Geology and Tectonics* is a foundation discipline for the Earth and Environmental Sciences and a prerequisite for EES 341, Field Methods in EES. 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 flowing glaciers to entire mountain ranges. *Tectonics* provides the context or boundary conditions, the driving forces, and the large-scale framework for lithosphere 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 January 2010 Haitian earthquake killed 316,000, the May 2008 Sichuan, China earthquake killed 87,587, and the December 2005 tsunami from a Sumatra earthquake killed ~250,000 people around the Indian Ocean. 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. The lecture and lab portions of this course are an integrated package. In addition to supporting lectures, course

laboratories will introduce field methods, orientation analysis, and geologic map analysis to continue your training as a field geologist.

**Homework:** Homework will be assigned most Tuesdays and are due the beginning of the next class period on Thursdays. Homework problems will be designed to take ~30 minutes. Homework exercises are designed to develop and refine problem solving and quantitative skills. The homework assignments will help you keep up with the material and to give you exam preparation. Homeworks will be checked and homework answers will be provided with your returned assignment. Anticipated homework assignments are designated by (H) on the syllabus.

### *Course Schedule*

- 1/14 *lab 1, Primary Structures, Course syllabus, and Introduction*  
15 Forces and Stress (H)  
17 Stress continued  
18 EES lecture, Professor David Rowley, University of Chicago, noon-1PM in STEPS  
100.
- 21 *lab 2 Strain Measurement*  
22 Deformation and Strain (H)  
24 Strain continued  
25 EES lecture, Professor Donald Fisher, Penn State University, noon-1PM in STEPS  
100.  
LAST DAY TO DROP/ADD WITHOUT A "W"
- 28 *lab 3 Planes, Lines, 3-point, and Complete the Outcrop Problems*  
29 Material Properties and Rock Rheology (H)  
31 Deformation Mechanisms and Microstructures  
2/1 LAST DAY TO SELECT OF DROP PASS/FAIL OPTION
- 4 *lab 4, Stereonets I*  
5 Crystal Plastic Deformation and Recovery  
7 **EXAM**
- 11 *lab 5, Fracture Mechanics and Faulting*  
12 Joints and Veins (H)  
14 Normal Faults  
15 EES lecture, Professor Peter La Femina Penn State University, noon-1PM in STEPS 100.
- 18 *lab 6 Geologic Maps*  
19 Strike-Slip Faults (H)  
21 Thrust Faults and Thrust Belts
- 25 *lab 7 Orientation Analysis–Stereonet II*  
26 Folding (H)  
28 Fold Kinematics

3/4 *lab 8 Balanced Cross Sections*

5 Fold Mechanics

7 **EXAM**

3/9-17 SPRING BREAK

18 *lab 9 Brunton Compass, pace and compass map, orientation measurement*

19 Foliations and Lineations (H)

21 Ductile Shear Zones, Shear Sense Indicators, Relative Ductility

22 D. Foster Hewlett Lectures, "Order and Emergence in a Non-Linear World", lecture  
times to be announced

24 *lab 10 Sunday Field Lab, Bear Valley Strip Mine 8:00AM-6:00PM*

25 *No Lab*

26 Earth Structure, Plate Boundaries (H)

28 Divergent Boundaries

4/1 *lab 11 Bear Valley Cross Section*

2 Passive Margins, Basin and Range-MCC

4 Convergent Boundaries

4/8 ***lab 12 LABORATORY PRACTICAL EXAMINATION***

9 Accretionary Tectonics (H)

11 P-T-t paths

12 LAST DAY TO DROP WITH A "W"

15 *lab 13 Plate Game*

16 Salt Tectonics (H)

18 **EXAM**

19 EES lecture, Professor Paul Kapp, University of Arizona, noon-1PM in STEPS 100.

19-21 *lab 14 Appalachian Transect MD and PA Valley and Ridge*

*Depart Friday Cumberland MD, camp Rocky Gap State Park, camp Saturday night at Pine Grove Furnace, return to Lehigh Sunday at 6:00PM*

22 No Lab,

23 Plate Circuits, Triple Junction Stability (H)

25 Appalachian Geology, Final paper review, Plate lab due.

26 Dr. Christine Regalla, Penn State University, noon STEPS 100,

Undergraduate Research Symposium

EES spring picnic, undergraduate awards, TA award

LAST DAY TO DROP WITH WP/WF GRADE

4/30-5/8 **FINAL PAPER**

**Equipment you must provide:**

Field notebook and clipboard for field labs  
Hard pencils 3H-5H, few colored pencils, erasers  
Protractor, transparent  
Engineering/scaled ruler  
Drawing Compass

**Course Evaluation:**

Exams 54% (18%, 18%, 18%)

Lab Exam: 10%

Laboratory Exercises Total: 26% (13 worth 4%, others 2%)

Homeworks: 10%

Attendance and Summary of indicated EES Seminars (Friday noon -1:00PM ) are worth up to a 10% bonus on same week laboratory exercise.

**Course Rules:**

Class and lab attendance is mandatory.

The fieldtrips will occur irrespective of weather; come prepared to be outside all day, closed shoes required on field trips, bring lunch and drinks if so instructed.

All assignments must be completed to pass course.

Labs are due to the TA by 1:10 lab day the following week unless otherwise indicated; late labs will not be accepted without professor's approval.

***Field Safety:***

Please exercise care on fieldtrips. Load and unload carefully from vans cognoscente of traffic, wear your seatbelt in transit. Dress for the weather and fieldtrip. Wear hardhats when necessary and safety glasses when hammering on rocks. Always follow faculty and TA instructions. Avoid proximity to steep highwalls in quarries and along road outcrops.

**Accommodations for Students with Disabilities:**

If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center 212 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.