Professor: Ryan Kerrigan Office: Krebs 227A E-mail: kerrigan@pitt.edu Class time: MWF 9:00-11:50 AM Lab time: W 2:00-4:50 PM

Office Hours: Thurs. 9:00-12:00 AM or by appointment Office Phone: (814) 269-2942 Class Room: Krebs B52 Lab Room: Krebs B52

Welcome to Structural Geology!

COURSE DESCRIPTION:

Structural Geology is a sub-discipline of geology which addresses stress, strain, and the deformation of rocks by examining and interpreting the spatial relationships of rocks and layers. Structural Geology is an upper-level geology course intended for junior or senior geology majors. The primary goals of this course are to teach the skills to: describe rock structures with proper terminology; understand the kinematic and mechanical processes that allow rocks to deform; and the ability to conduct detailed analysis of rock deformation. This class builds upon primary knowledge of geologic structures (folds, faults, etc.) taught in lower-level courses (*Prereq: GEOL 0061 Historical Geology or GEOL 0200 Geodynamics*) and expands upon these topics focusing on the three-dimensional nature of structural features, how these features fit into tectonic settings, and the basic mechanical development of such features. To develop these skills the lecture and laboratory aspects of this course are heavily integrated.

This course is taught in a "flipped classroom" model. This means there will be recorded 20-30 min lectures that will be assigned as homework. Students are expected to watch the videos, take notes, and be prepared for a quiz and exercise heavily based on material covered in the lecture. Without watching the lectures, this model completely falls apart and everyone is unhappy, trust me. One of the most important skills learned in Structural Geology is the three-dimensional visualization of geologic structures, with the flipped model we will have more time for hands-on exercises that will develop your skills in 3-D visualization. Lab sessions will further apply skills learned in lecture with more in-depth problems geared toward practical application (i.e., drill-hole interpretation, geologic mapping, oil/gas exploration, etc.). Nearly all problems are approached visually as well as derived mathematically. Students are taken on several field trips to both local and regional geologic structures to study the geologic features discussed in class. Field trips and field work are an important teaching tool in Structural Geology and there are virtually no substitutes for reinforcing the theoretical elements discussed in class.

GOALS

- The primary purpose of this class is to help you conceptualize the principles of structural geology, the study of deformation in rocks. By the end of the course, you should be able to:
 - o Describe rock structures with proper terminology
 - Understand the kinematic and mechanical processes that allow rocks to deform
 - Be able to conduct detailed analyses of rock deformation

Required Texts:

Structural Geology by Haakon Fossen, 2nd edition, 2011, Wiley, ISBN-10: 1107057647, ISBN-13: 978-1107057647 (~\$50 new, ~\$55 used)

Lab Texts (don't buy these, I'll give you the labs):

Structural Analysis and Synthesis: A Laboratory Course in Structural Geology by Rowland, Duebendorfer, and Schiefelbein, 3rd Edition, 2007, Wiley, ISBN-13: 978-3642008641, ISBN-10: 364200864X (~\$60 new – buy it new, students have had issues with used purchases) Modern Structural Practice: A structural geology laboratory manual for the 21st century. by Allmendinger, Richard, 2020, This is a free download. https://www.rickallmendinger.net/download

Additional resources:

This text (*Structural Geology* by Haakon Fossen) has a variety of online resources that we will utilize throughout the semester. These are great, but I have had a tough time running them now that Abode Flash is dead. If you figure out how to play them, let me know, because they are great...

Text E-Modules: <u>http://folk.uib.no/nglhe/StructuralGeoBookEmodules.html</u> Text Problems: <u>http://folk.uib.no/nglhe/Additional%20Problems.pdf</u>

Additional readings and class exercises will be posted and made available for use, if necessary. All readings (textbook, e-learning modules, and other postings) should be read prior to our in-class discussion of the material to help reinforce learned concepts. I will elaborate on the most important points of the chapter readings as the course progresses.

Other required materials:

Protractor, ruler, 360° compass, colored pencils, tracing paper, graph paper (white, not green), scientific calculator, and Field book (all should be available at the bookstore).

Evaluation of the Course

Exercises and other course materials will be provided in class. It will be hard to "make up" missed classes. Reading and e-module assignments are designed to give more detail on many topics than time allows for in class presentation. These additional assignments are an important part of the course and do not just reiterate lecture material. Some topics in the reading and e-modules will not be covered in class but will appear on exams. The points of individual labs, quizzes, and exams may vary. However, your points will be weighted such that your final grade will be calculated as follows:

| 20% | Lecture Quizzes |
|-----|--|
| 10% | Lecture Exercises |
| 10% | Laboratory Exercises |
| 5% | Laboratory Final |
| 5% | Term Project |
| 50% | Exams, which is subdivided into three parts: |
| | 15% Exam I |
| | 15% Exam II |
| | 20% Final Exam |
| | Please do not ask for extra credit or extra assignments to get extra credit. |

LECTURES:

Lectures will be posted to Canvas each week. Students are expected to have watched the lectures and completed notes on those lectures. Each lecture period will begin with a quiz. You are permitted to use your notes on the five question multiple-choice quizzes. The lectures are intended to provide background for the in-class exercises, and therefore, it is extremely important the lectures are consumed prior to class.

CLASS EXERCISES:

The class exercises will be based off the assigned reading, lectures, and labs. Questions are designed to make sure that you have learned the material and are prepared for the next class (i.e., have completed the reading/online lectures). They will be posted to Canvas prior to class meetings so remote students can access them.

LABS:

Labs are designed such that a student who is current with the class material should be able to complete the lab in the time allotted. However, some labs will at times be more difficult and require work outside of class time. Most lab exercises will involve graphical and analytical solutions to geometric problems, whereas other labs may emphasize the study and interpretation of geologic maps, since these offer the best alternative to visiting structures in the field. We will also explore hand sample and thin-section observation, structural analytical techniques, and other methods. Lab topics will parallel those covered in concurrent lectures as closely as possible, but there may not always be a perfect overlap. At times, materials will be made available for use. Out of courtesy to others, please <u>do not</u> remove any materials from the lab.

You are expected to use all of the resources at your disposal, including your wits, the internet, each other (when acceptable), as well as the instructor. You are responsible for turning in *your own* work. Working with other students is encouraged, however, blatantly copying another student's work is unacceptable.

Please take care in preparing lab reports, since your grade will in part depend on the presentation of your reports. Write clearly, draw clearly and carefully what you see, and annotate captions with strings of words that make sense. If you feel your handwriting will be a hindrance to the professionalism of your reports, **type**. Please, thoroughly read the questions posed so that you answer all that is being asked of you. Labs are due at the start of lab the following week after they are assigned, unless stated otherwise. Late assignments will lose 10% of their value for each day that they are late, this includes weekend days.

EXAMS:

The best way to study for the exams will be discussed in class. All students are expected to take exams at the scheduled time unless they have a medical excuse signed by the Assistant Vice President for Academic Affairs, Dr. Steve Kilpatrick. **I must be notified prior to** any exam being missed for a makeup to be possible. The final exam is scheduled for Friday, December 13th at 8:00 AM.

FIELD TRIP:

Fieldwork is at the core of structural geology and it is in this environment that students link learned course concepts to the observation of natural phenomena around them. Consequently, we will have one full weekend fieldtrip for this course tentatively scheduled for **September 28th and September 29th** (Sat and Sun). We will be camping one night and as the date approaches we will coordinate needed equipment. There will be an assignment connected with the fieldtrip. Students unable to attend the fieldtrip will miss a great deal, and will need to do a <u>substantial</u> make-up assignment. Attendance on the fieldtrips is required, I will discuss everyone's schedule the first week of class and determine if people have conflicts. Additional details will be provided regarding the field trip so that students can plan accordingly.

EXPECTATIONS:

The study of structural geology is both challenging and fun. You will have the chance to learn in a hands-on way in class and lab, and I hope you find this class both enjoyable and challenging. A few things to keep in mind will maximize your potential success in this course:

<u>Attendance:</u> I do not take attendance, but you are expected to attend each class and lab. Much of the learning takes place in the classroom and laboratory, and often cannot be made up or reproduced, so be in class. Attendance is also a great predictor of grades! It is your responsibility if you miss a class and you will be held accountable for any reading assignments, exams, and any deadlines or changes announced. If you do miss a class, see your classmates to make up for what you have missed. Please contact me if you have any further questions or a scheduled absence.

Prerequisites: I assume a basic understanding of physical and historical geology, including elementary

nomenclature for such topics as rock classification, geologic time, and stratigraphy. A working knowledge of trigonometry and the manipulation of basic mathematic equations are essential.

- <u>Assignments / workload:</u> It is also essential that you read the assigned pages and e-modules prior to class and participate in class. As with your other courses, you should expect to spend about 2-3 hours outside of class for each credit hour. So for this class, expect to spend a minimum of 9 hours *outside* of class each week reading, working on the quizzes, exercises, and labs.
- <u>Learning accommodations</u>: If you require any course adaptations or accommodations, please make an appointment to discuss these or other important matters with me as soon as possible.
- <u>Diversity and Inclusion</u>: Our classroom will be one of acceptance and inclusion. Any form of discrimination, bullying, etc. will not be tolerated. Please review the university's statement of Equity and Inclusion, if you are unfamiliar: <u>https://www.johnstown.pitt.edu/about/office-president/equity-and-inclusion</u>
- <u>Ask for help:</u> Please seek help if you are confused or in need of clarification. Also please visit me at office hours.

<u>Academic integrity:</u> UPJ values the academic integrity of its students and faculty. It is your responsibility to familiarize yourself with the university's policy on academic integrity (http://www.upj.pitt.edu/globalassets/documents/academics/upj-academics-integrityguidelines.pdf).

Violations of academic integrity will be reported to and judged by the academic integrity committee. If you are found responsible for violating the policy, penalties may include a failing grade as well as possible probation, suspension, or expulsion, depending on the seriousness and circumstances of the violation and your history of past violations.



| Schedule of Events | | | | | | | |
|--------------------|----------------------------------|----------------------------------|--|---------------------------------------|--|--|--|
| Week | Monday (Lec) | Wednesday (Lec) | Wednesday (Lab) | Friday (Lec) | | | |
| | <u>August 26, 2024</u> | <u>August 28, 2024</u> | <u>August 28, 2024</u> | <u>August 30, 2024</u> | | | |
| 1 | Intro to Structure | Strike , Dip, and Bruntons | Strike and Dip | Review of Basic Structures I | | | |
| | <u>September 2, 2024</u> | <u>September 4, 2024</u> | <u>September 4, 2024</u> | <u>September 6, 2024</u> | | | |
| 2 | NO CLASS LABOR DAY | Review of Basic Structures II | Attitudes of lines and planes | Deformation: Displacement & Strain | | | |
| | <u>September 9, 2024</u> | <u>September 11, 2024</u> | <u>September 11, 2024</u> | <u>September 13, 2024</u> | | | |
| 3 | Deformation: Strain Ellipses | Stress Normal & Shear | Outcrop Patterns and Structure Contours | Stress: Mohr's Circle | | | |
| | <u>September 16, 2024</u> | <u>September 18, 2024</u> | <u>September 18, 2024</u> | <u>September 29, 2024</u> | | | |
| 4 | Stress: Coulomb Failure | Rheology: Intro Terms | Interpretation of Geologic Maps | Rheology: Confining Pressure | | | |
| | <u>September 23, 2024</u> | <u>September 25, 2024</u> | <u>September 25, 2024</u> | <u>September 27, 2024</u> | | | |
| 5 | Rheology: Pressure and Fluids | Rheology: Temp & Heat | Geologic Structure Sections | Rheology: Strain Rate & Diff Press | | | |
| | <u>September 30, 2024</u> | <u>October 2, 2024</u> | <u>October 2, 2024</u> | <u>October 4, 2024</u> | | | |
| 6 | Rheology: Brittle-Ductile | EXAM I | Stereonets I: Lines and Planes | NO CLASS FIELD CONFERENCE | | | |
| | <u>October 7, 2024</u> | <u>October 9, 2024</u> | <u>October 9, 2024</u> | <u>October 11, 2024</u> | | | |
| 7 | Folds: | Folds: | Stereonets II: | Folds: | | | |
| | October 14 2024 | October 16 2024 | October 16 2024 | October 18 2024 | | | |
| 8 | NO CLASS FALL BREAK | Folds: | Stereonets III: Restorations | Folds: Parasitic | | | |

| Schedule of Events | | | | | | | |
|--------------------|--------------------------|----------------------------|---|--------------------------|--|--|--|
| Week | Monday (Lec) | Wednesday (Lec) | Wednesday (Lab) | Friday (Lec) | | | |
| | <u>October 21, 2024</u> | <u>October 23, 2024</u> | <u>October 23, 2024</u> | <u>October 25, 2024</u> | | | |
| 9 | | | | Last day to withdraw | | | |
| , | Folds: | Joints: | Folds: | Joints: | | | |
| | Cleavage & Folding | Definitions | | Joint Sets | | | |
| | <u>October 28, 2024</u> | <u>October 30, 2024</u> | <u>October 30, 2024</u> | <u>November 1, 2024</u> | | | |
| 10 | | | | | | | |
| | Faults: | Faults: | Faults | Faults: | | | |
| | Definitions | Components & Features | | Features & Surfaces | | | |
| | <u>November 4, 2024</u> | <u>November 6, 2024</u> | <u>November 6, 2024</u> | <u>November 8, 2024</u> | | | |
| 11 | | | | | | | |
| | Faults: | Faults: | Dynamic & Kinetic | Faults: | | | |
| | Rocks & Stresses | Compressional | Analysis of Faults | Tensional | | | |
| | <u>November 11, 2024</u> | <u>November 13, 2024</u> | <u>November 13, 2024</u> | <u>November 15, 2024</u> | | | |
| 12 | Foulto | Testopies | Palanced Cross | EVAM II | | | |
| | Shear | 8. Review for Evam | Sections | EAAM II | | | |
| | November 18, 2024 | November 20, 2024 | November 20, 2024 | November 22, 2024 | | | |
| | | <u>1101011101110, 2021</u> | <u>11070111001 10, 1011</u> | | | | |
| 13 | Metamorphic Facies | Foliations, Cleavages, | Bree Creek Ouad | Lineations. Tectonites. | | | |
| | and Foliations | and Flinn Plots | Catch Up | and Kinematic Indic. | | | |
| | <u>November 25, 2024</u> | <u>November 27, 2024</u> | <u>November 27, 2024</u> | <u>November 29, 2024</u> | | | |
| | | | | | | | |
| 14 | NO CLASS | NO CLASS | NO LAB | NO CLASS | | | |
| | | | | | | | |
| | <u>December 2, 2024</u> | <u>December 4, 2024</u> | <u>December 4, 2024</u> | <u>December 6, 2024</u> | | | |
| 15 | | | | | | | |
| | Tectonics: | Tectonics: | FINAL LAB EXAM | Tectonics | | | |
| | Appalachia | Spring Break Location | | Your Choice | | | |
| | <u>December 9, 2024</u> | | Friday | | | | |
| 16 | Review for Exam | | December 13th 8:00 AM - 10:00 | | | | |
| | | | FINAL EXAM | | | | |

*This schedule will be fluid at times to adjust for the pace and comprehension of the class.