GEOL 408 STRUCTURAL GEOLOGY (4-credit)

SPRING 2021 Class meeting: MW 10:20 am-12:20 pm (Web-Synchronous)



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COURSE PREREQUISITES

Course prerequisites: GEOL 111 and 113 or permission by the instructor.

COURSE OBJECTIVES

Structural Geology satisfies the core course requirement for the students majoring in Geology, Earth Science, and elective course requirement for the students in other majors (i.e., Civil Engineering, Middle School Science). This course prepares students for advanced geology courses that include but are not limited to tectonics, geomorphology, geodynamics, petroleum geology, geophysics, advanced structural geology. This course provides two significant components: lecture and laboratory. The lecture part is designed to provide a fundamental understanding of brittle and ductile deformation such as fold, fault, joints and foliation on the Earth's crust and upper mantle. This course also explores the development, geometry, pattern, timing, and kinematics of deformation at all scales starting from atoms in crystals to the collision in mountain belts. The laboratory component is designed to complement technical aspects and critical thinking skills through comprehensive hands-on graphical, quantitative and technological experience including problem-solving, geometrical construction, interpretation, observation and industry application (e.g. topographic and structure contours, geologic cross-section, fold, fault and fracture analysis, paleo stress, stereographic projection, structural restoration, stress & strain analyses, seismic interpretation, etc.). This course will introduce various concepts and tools of structural geology that will help students gain valuable experience for their professional geoscience career.

STUDENT LEARNING OUTCOMES

Upon successful completion of this course, students will be able to:

- 1. understand complex processes of rock deformation that occur near and beneath the Earth's surface.
- 2. describe concepts of how fundamental geologic structures evolve through time.
- 3. develop skills in structural data collection, measurement and interpretation using techniques in the laboratory and/or in the field.
- 4. identify and demonstrate deformation in minerals rocks in thin-section, hand specimen and outcrop.
- 5. read, construct, and interpret structure contours, geologic maps and cross-sections.
- 6. relate structures/stress patterns with regional tectonics.
- 7. efficiently utilize structural geology knowledge in hydrocarbon exploration decision making, natural

hazard mitigation, geotechnical risk assessment, engineering geology, environmental geology, petroleum/mining, mineral resource exploitation and groundwater exploration.

- 8. understand the importance of geologic structures within the context of societal and environmental issues in the Anthropocene.
- 9. improve communication skills through reading articles, discussion, and structural data analysis.

TEXTBOOK

Required text:

Structural Geology, 2016–Haakon Fossen, 2nd Edition, Cambridge University Press, 524 pp. ISBN13: 9781107057647/1107057647. E-module for this textbook, very useful and interesting, is available at https://folk.uib.no/nglhe/StructuralGeoBookEmodules2ndEd.html

Recommended texts for lab section:

- Structural Analysis and Synthesis: A Laboratory Course in Structural Geology, 2007–Stephen M. Rowland, Ernest M. Duebendorfer, and IIsa M. Schiefelbein, 3rd Ed. Blackwell Publishing, 301 pp.
- Basic Methods of Structural Geology, 1988–Stephen Marshak and Gautam Mitra, Prentice Hall, 446 pp.
 Structural Geology: An introduction to geometrical techniques, 2009–Donal M. Ragan, 4th Ed.
- Cambridge University Press, 602 pp. Older version is available at WKU Cravens Library (QE601.R23)
 Structural geology and map interpretation, 1997 Rudd Weijermars, Dhahran, Saudi Arabia: Alboran
- Science Publishing, 378pp. Available at WKU Cravens Library (QE601.W35x 1997)

Additional class materials will be posted on class blackboard.

You are responsible for:

- reading the textbook and knowing all lecture materials including terminology, concepts, pictures, and figures.
- knowing all lab materials, techniques of lab construction, interpretations and calculations, and lab submissions.
- familiarizing with any relevant course materials like e-module, video content, website, etc.
- reading (MUST) Fossen's Structural Geology text before each class (All the lectures and lab assignments for this course are designed to augment the materials covered in the text).

LEARNING ASSESSMENT CATEGORIES (any changes in the learning assessment categories will be posted on Blackboard and announced in class)

Final Grade will be based on the following categories: Grades will be routinely posted on the Blackboard

Categories	Percentage	
Three exams	45%	
Lab assignments	35 %	
Quizzes	15%	
Attendance	5%	

Grades are based on straight percentages:

Grade Policy:

No curving in grades. I will keep records of your scores (that you will receive in exams, labs, and quizzes) throughout the semester. Keep in mind that these scores do not imply your final grade. I suggest you keep track of your grades based on the above percentage in an excel spreadsheet to know how you are progressing in the class. Note that any late work will not be accepted for a grade unless a <u>VALID university excuse</u> is presented to me.

Exams (45%)

Exams will be a combination of multiple-choice, fill-in-the-blanks, but largely short answer, essay and higherorder thinking skill questions (e.g., based on diagrams, sketches, calculation). All tests are closed book/notes. All materials covered in the lecture and/or lab period is open for test questions.

Lab assignments (35%)

The goal of lab assignments is to allow you to enhance your understanding of the materials covered in lecture classes through hands-on-activities including problem solving, geometrical construction, data interpretation, mapping and analyzing. Labs are designed to help you build fundamental skills on traditional and practical tools and techniques for structural data observation, illustration, calculation, analysis and interpretation. Generally, each lab will follow the materials covered in lectures (subject to change by Dr. Gani); some labs are independent but important, and not necessarily linked with lecture materials.

Each lab assignment is due at the beginning of the next lab class. Remember, you have one week to complete one lab. Assignments turned in late but within the first two days after the due date, will be graded with a 10-point reduction. After the first two days from the due date, no labs will be graded without a verifiable university excuse. For labs, group working may be allowed but **each of you will submit your own write-ups and constructions/calculations/maps.** Be neat and clean in your calculation, drawing/sketches and illustration. All **sketches must be done with a pencil, if needed.** Once you complete a lab assignment, it is important that you make sure you understand that lab concept and constructional/technical steps very well as you will be given several different labs with similar constructional/technical steps throughout the semester. This is true for each lab assignment.

Some labs will accompany a short pre-lab assignment (will be included in the lab grade) that you will complete on your own before or in some cases in the class. This is a commitment and assessment of your learning progress in the lab portion of this course.

Quizzes (15%)

Blackboard quizzes will count 15% of your grade. Each quiz will be from lecture materials.

Attendance (5%)

Registration in a course obligates you to be regular and punctual in class attendance. Students who, without previous arrangement with the instructor or department, fail to attend the first two class meetings of a course meeting multiple times per week or the first meeting of a class that meets one time per week MAY be dropped from the course. Those of you who cease attending class are expected to report to the Office of the Registrar to initiate withdrawal procedures. As you noticed above that your class attendance counts 5% of your grade, it is YOUR RESPONSIBILITY to attend class regularly. Attendance will be taken at the end of each class. If you arrive late or leave early, or sleep at any time during class, you will be considered absent.

Your attendance will be graded based on the number of your absences: <u>You will receive a full 5%</u> will be added to the final grade if you don't miss any lecture or lab class.

PERFORMANCE MEASURES

In-class attentiveness, note-taking and lab assignment completion on time during lecture and lab classes will be used to monitor your learning commitment and improvement on a regular basis. Students who perform well on these materials will definitely perform well on exams.

MISCELLENY

My expectation to you and ways to succeed in this course:

• <u>Your enrollment in the class obligates you to WKU student code of conduct.</u> The free exercise of knowledge including discussion, expression of enthusiasm, and inquiry are encouraged in academic environments inside and outside of the classroom. Such actions should be conducted in a professional manner. For more information, see WKU current undergraduate catalog at

http://www.wku.edu/undergraduatecatalog/

- You MUST avoid irrelevant talking and laugh with each other or any sort of academic disruption during class hours. You MUST respect your colleagues/classmates during class time.
- Read relevant book chapters before you come to every class. While you read, prepare and bring the question/problems you do not understand.
- You must take detailed notes during lectures and lab classes.
- <u>USE my office hours effectively (see Instructor Information above) for your lab help.</u> I invest my time and effort to design all course materials effectively to make your learning exciting and important. I also expect you will invest your time effectively, so that you can get the best learning experience from this class and earn a better grade in the class.
- Ask questions to clarify any concepts/materials that you do not understand. I am there to help, as you need.
- Concentrate most on studying for the scheduled exams, and completing all the homework assignments.
- <u>Cell phones must be turned off and out of sight during lecture and lab hours.</u>

ADA accommodation: In compliance with University policy, students with disabilities who require academic and/or auxiliary accommodations for this course must contact the Student Accessibility Resource Center located in Downing Student Union, Room 1074. The SARC can be reached by phone number at 270-745-5004 [270-745-3030 TTY] or via email at sarc.connect@wku.edu. Please do not request accommodations directly from the professor or instructor without a faculty notification letter (FNL) from The Student Accessibility Resource Center.

Title IX/discrimination & harassment: Western Kentucky University (WKU) is committed to supporting faculty, staff, and students by upholding WKU's Title IX Sexual Misconduct/Assault Policy (#0.2070) and Discrimination and Harassment Policy (#0.2040). Under these policies, discrimination, harassment and/or sexual misconduct based on sex/gender are prohibited. If you experience an incident of sex/gender-based discrimination, harassment and/or sexual misconduct, you are encouraged to report it to the Title IX Coordinator, Andrea Anderson, 270-745-5398 or Title IX Investigators, Michael Crowe, 270-745-5429 or Joshua Hayes, 270-745-5121. Please note that while you may report an incident of sex/gender-based discrimination, harassment and/or sexual misconduct to a faculty member, WKU faculty are "Responsible Employees" of the University and MUST report what you share to WKU's Title IX Coordinator or Title IX Investigator. If you would like to speak with someone who may be able to afford your confidentiality, you may contact WKU's Counseling and Testing Center at 270-745-3159.

Schedule Change Policy: The Department of Earth, Environmental, and Atmospheric Sciences strictly adheres to University policies regarding schedule changes. It is your responsibility to meet all deadlines for drop/add. Only in exceptional cases will a deadline be waived (you would be required to fill out an appeal form). The form requires a written description of the extenuating circumstances involved and the attachment of appropriate documentation. Poor academic performance, general malaise, or undocumented general stress factors are not considered as legitimate circumstances.

Academic assistance through The Learning Center (TLC): Should you require academic assistance with your WKU courses, The Learning Center (located in the Downing Student Union, 2141) provides free supplemental education programs for all currently enrolled WKU students. The Learning Center at Downing Student Union offers certified, one-on-one tutoring in over 200 subjects and eight academic skill areas by appointment or walk-in. Online tutoring is offered to distance learners. TLC is also a quiet study area (with side rooms designated for peer-to-peer tutoring) and a computer lab to complete academic coursework. Please call TLC in the Downing Student Union at (270) 745-5065 for more information or to schedule a tutoring appointment. www.wku.edu/tlc

Academic integrity: Students are expected to conduct themselves according to the principles defined in the WKU Student Code of Conduct at <u>https://www.wku.edu/studentconduct/student-code-of-conduct.php</u>. Students who commit any act of academic dishonesty may receive from the instructor a failing grade in that portion of the course work in which the act is detected or a failing grade in a course without the possibility of withdrawal. No student shall receive or give assistance not authorized by the instructor in taking an examination or in the

preparation of an essay, laboratory report, problem assignment or other project, which is submitted for purposes of grade determination. Any student or group found to have committed an act of academic dishonesty shall have their case turned over to the Office of Student Conduct for disciplinary action. Academic dishonesty includes, but is not limited to cheating, plagiarism, fabrication, or misrepresentation, and being an accessory to an act of academic dishonesty. For more, see https://www.wku.edu/handbook/academic-dishonesty.php/. Student Handbook is available at https://www.wku.edu/handbook/academic-dishonesty.php/.

Tentative Course Contents

(Subject to change by the Instructor with notification; any changes in syllabus content will be announced in class and posted on Blackboard and TopNet)

Week	Date	Lecture Topics	Chapter Reading	Reading Quiz (Wednesdays)	Lab assignments
Week 1		Theme I: Introduction and structural toolkit			
	1/20	Structural Geology and structural analysis	1	Quiz 1	
Week 2		Theme II: Deformation in the Upper Crust			
	1/25	Fracture and brittle deformation	7		Lab 1
	1/27	Joints and veins	7,8	Quiz 2	
Week 3	2/1	Joints and veins; Faults	8, 9		Lab 2
	2/3	Faults	9	Quiz 3	
Week 4		Theme III: Stress concepts and deformation			
	2/8	Stress	2, 4, 5, 7, 8		Lab 3
	2/10	Stress	8, 9, 10	Quiz 4	
Week 5	2/15	Exam 1			
		Theme IV: Deformation in the middle crust			
	2/17	Folds and folding	12		Lab 4
Week 6	2/22	Feedback on Exam 1; Folds and folding	12		
	2/24	Boudinage	15	Quiz 5	
Week 7		Theme V: Strain concepts			
	3/1	Strain	2, 3		Lab 5
	3/3	Strain		Quiz 6	
Week 8		Theme VI: Deformation in the lower crust			
	2.40	and upper mantle	10		
	3/8	Foliation and cleavage	13		Lab 6
Wook 9	3/10	Fyam 2			
WCCK /	3/17		14		
Week 10	3/22	Shear zones and mylonites	16		Lab 7
	3/24	Feedback on Exam 2: Shear zones	16		
Week 11	3/29	Basic rheology	6		Lab 8
	2/21	Deformation at the microscale	11		
Week 12	5/51	Theme VII: Regional structures			
WOORTZ	4/5		17		Lab 9
	4/7	Extensional regimes	18	Quiz 9	
Week 13	4/12	Strike-slip, transtension & transpression	19		Lab 10
	4/14	Salt Tectonics	20	Quiz 10	
Week 14	4/19	Salt Tectonics	20		
	4/21	Exam 3	-		

Enjoy your semester with structure fun