GEOL 401 Structural Geology Syllabus – Spring 2022

Instructor: Dr. Paul Betka
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Office hours: TBD Exploratory Hall 3455 or virtual

GEOL 401-001 (W,F lecture 12-1:15pm) Exploratory Hall 1005
GEOL 401-201 (F lab 2-4:45pm), Friday afternoon field trips will occur from 12-4:45pm

Required Textbook: Structural Geology 2nd Edition, Haakon Fossen.
Recommended textbooks: Basic Methods of Structural Geology, Marshak and Mitra.
Structural Geology of Rocks and Regions, Davis and Reynolds.

Course Description: An introduction to both qualitative and quantitative methods of structural geology with emphasis on identifying and analyzing geologic structures in nature as well as learning the fundamentals of geological stress and strain, rock mechanics, and tectonic deformation. Prerequisites: GEOL 302, 317, 304, or 308; MATH 110, or 111, or 113.

Course Objectives: The field of structural geology examines the processes by which rocks are deformed from the atomic scale to entire mountain belts. The analysis of geologic structures across spatial and temporal scales is fundamental for understanding the architecture and evolution of Earth's tectonic plates as well as the forces that drive crustal deformation. Structural geology also has numerous, often profitable, industry applications including geological hazard assessment (e.g. active faults, landslides and earthquakes), hydrogeology, engineering geology, materials sciences, soil mechanics, and natural resource exploration. This course is designed to help you develop analytical techniques to solve structural geology problems as well as introduce you to both theoretical and empirical concepts in rock mechanics and tectonic deformation. The goals for this course are to help you:

- Identify and describe geologic structures using geologic maps, cross-sections, and field measurements (e.g. strike/dip data).
- Develop an improved ability to analyze geologic features in 3D and through time ('4D').
- Develop a quantitative understanding of the forces (e.g. tectonic stress) that drive rock deformation (strain).
- Utilize different types of geological data and analytical methods to solve geologic problems.

Assessment: The final grade for this class will be a combination of mid-term exams, lab assignments, and term project, and a final exam:

Mid-term exams (2)……..……...30%
Lab assignments (12)…….……..……..60%
Final exam (1)…….……10%

Final Exam Date: Friday May 7, 10:30-1:15 EXPL 1005, in person.

Grade scale:
A+ = 97 - 100%, A = 94 – 97%, A- = 90 – 94%, B+ = 87 – 90%, B = 84 - 87%, B- = 80 - 84%, C+ = 77 - 80%, C = 74 - 77%, C- = 70-74%, D = 60 - 70%, F = 0 - 60%

Required equipment for labs: Tracing paper, ruler, graph paper, protractor, calculator with trig. functions, ALL class handouts. **If you prefer, some assignments may be completed with vector-based computer programs (e.g. Adobe Illustrator), you are responsible for printing hard-copies of all assignments and documenting your work.

Week	Topic	Readings Fossen, 2nd ed.	Wed. Lecture	Fri. Lecture	Friday Lab / Fieldtrip
Jan. 26, 28	Introduction to structural geology;	Ch. 1	Introduction, Syllabus, Fieldtrips,	Map patterns, Linear and Planar Structures.	**Lab 1:** Lines, planes, apparent dip. Map patterns and geometric techniques.
Feb. 2, 4	Maps and structural techniques	Ch. 2.1-2.16 & 3	Map patterns and geometric techniques.	**Fieldtrip 1: Thoroughfare Gap, VA.** **Lab 2, FT1:** strike and dip skills.	
Feb. 9, 11	Strain	Ch. 2.1-2.16; 3	2D/3D strain analysis, strain tensors I	2D/3D strain analysis, strain tensors II	**Lab 3:** Strain analysis
Feb. 16, 18	Stress and rock failure criteria	Ch. 4 and 5; 7.3	Introduction to Stress; Stress definition, components, and Mohr circles I	Stress definition, components, and Mohr circles II	**Lab 4:** Introduction to Mohr circles, rock mechanics, pore-pressure
Feb. 23, 25	Rheology, stress in the lithosphere	Ch. 5, 6.1–6.3.	Stress in Lithosphere, Elasticity .	Exam review	**Lab 5:** Mohr circles II.
Mar. 2, 4	Exam I. Brittle deformation (fractures and faults)	Exam review: Ch. 1-6.3, and 7.3 Ch. 7-8	**EXAM I**	Brittle deformation: Joints, veins, and deformation bands.	**Lab 6:** Stereogram analysis of Joints, veins and faults.
Mar. 9, 11	Kinematic analysis, paleostress and folding	Ch. 9-10, 12	Faults and fault kinematics, paleostress	Folds and Folding; fold vergence; secondary folds	**Lab 7.** Stereogram analysis of folds, rotation techniques.
Spring Break! March 14-18					
Mar. 23, 25	Foliation, cleavage, and lineations	Ch. 13, 14	Foliations, cleavage and lineation	**Fieldtrip 2: Point of Rocks, Leesburg, VA.** **Lab 7B:** Stereonet applications. **FT 2:** Data collection and analysis.	
Mar. 30, Apr. 1	Introduction to microscale deformation	Ch. 6, 11	Rheology: viscous-elastic-plastic deformation	Microscale deformation mechanisms	**Lab 8:** Structural analysis of folds and faults.
Apr. 6, 8	Ductile-plastic deformation	Ch. 15, 16	Boudinage, shear zones and mylonites I	Boudinage, shear zones and mylonites II.	**Lab 9:** Analysis of microstructures and shear zones
Apr. 13, 15	Exam II	Exam review: Ch. 6-16. Also Ch. 2-3	Exam review	**EXAM II**	
Apr. 20, 22	Contractional Tectonic regimes:	Ch. 17	Fold-thrust belts I	Fold-thrust belts II	**Lab 10:** Cross section construction I
Saturday, April 23. Valley and Ridge Province, Appalachian fold-thrust belt field trip, Hancock, MD; Harper's Ferry, WV			**Fieldtrip 3. Hancock, MD; Harper's Ferry, WV.** Valley and Ridge Province: Field structural analysis and data collection		
Apr. 27, 29	Extensional Tectonic regimes	Ch. 18	Rift basins and modes of extension; orogenic collapse	Field trip data analysis and geologic map datasets.	**Lab 11:** Field Trip cross section construction.
May. 4, 6.	Strike-slip, transpression & transtension tectonic regimes	Ch.19	Strike-slip regimes: Trans-pression (trans-tension)	**Final Exam Review (Alex and Austin)**	

Final Exam: TBD EXPL 1005.

DISABILITIES: Students with disabilities or medical conditions that affect classroom performance should contact GMU Disability Support Services immediately at 993-2474. NOTE: Students will not receive any disability accommodations unless official GMU paperwork from Disability Resource Office is provided for and signed by Dr. Paul Betka.

HONOR CODE: Adherence to the GMU honor code is expected of all students. Lab exercises are expected to be individual efforts, unless teams are specifically assigned. Students are encouraged to discuss the concepts and procedures among themselves, but each student is expected to complete the lab assignment individually using their own words.

To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University Community and with the desire for greater academic and personal achievement, we, the student members of the university community, have set forth this Honor Code: Student Members of the George Mason University community pledge not to cheat, plagiarize, steal, or lie in matters related to academic work.
[http://academicintegrity.gmu.edu/honorcode]