PROGRAMMATIC GOAL:
This undergraduate course prepares geology students to be able to consider kinematic processes in the evaluation of local and global geologic history.

COURSE CONTEXT:
This course is one of the foundational courses required for the Geology and the Earth and Space Sciences majors and is generally taken after students have the basic understanding of the nature and origin of geologic materials through courses in mineralogy (GEO306), petrology (GEO407), and sedimentology (GEO403). Graduate students in the Masters of Teaching program can obtain this preparation by enrolling in the graduate equivalent course (GEO506), in which they additionally indicate mastery of the material at the Masters level by a research paper that goes into depth on one aspect of this material.

As the course involves application of mechanics to geological systems it builds upon one semester each of physics and calculus.

INSTRUCTIONAL COMPONENTS:
1. Mathematical skill development
   - reinforcement of trigonometric skills
   - introduction of the basics of tensor properties and matrix manipulation
   - practice in the calculation of stress and strain and the use of Mohr circles.

2. Concept development
   - response of geologic materials to stress
   - recognition of strain markers at the small scale
   - recognition of large-scale strain marker
   - geologic structures in a tectonic context

3. Practical application
   - direct measurement of planes and lines using a pocket transit
   - experimental measurement of friction
   - representation and manipulation of geometries using stereonets
   - analysis of stress and strain
   - analog modeling of thin-skinned tectonics
   - mapping exercises, both on paper and using computer resources, including Google Earth
   - field trip to the Mid-Hudson Fold and Thrust Belt to analyze geological structures in situ, which serves as a capstone for the course, integrating much of the descriptive, geometric, and mechanical theory introduced throughout the term.
4. **Scientific communication**
   - laboratory write-ups
   - ???

**COURSE LOGISTICS:**
The course content is distributed through 3 50-minute professor-given lectures, one 3–hour professor-led laboratory session per week and one weekend field trip in the semester. A graduate teaching assistant assists during the laboratory sessions and assists with grading.

**EXPECTED COURSE OUTCOMES:**
By the end of the course, students will be able to:

1) **Calculate and analyze stress using Mohr circles**
   a) understand the physical basis for the stress tensor and the Mohr construction
   b) use the Mohr diagram to represent alternative yield criteria
   c) calculate the effects of pore fluid pressure on brittle fracture

2) **Identify strain markers and use graphical representations for analyzing strain**
   a) recognize and measure strain indicators
   b) understand infinitesimal and finite strain

3) **Analyze the relations among geometrical features in 3 dimensions**
   a) measure planes and lineations
   b) plot and interpret their relationships
   c) stereographically determine structural trends from field measurements
   d) constrain regional tectonics using stereographic calculations

4) **Identify and interpret folds, faults, shear zones, joints, cleavage and rock fabric**
   a) recognize and quantify fold geometry from field measurements
   b) identify and characterize faults, and understand their relationship to folds
   c) recognize cleavage in the field, and interpret its relation to lithology
   d) identify joints and understand their mechanical implications

5) **Interpret geologic maps, relating 2-dimensional exposures to 3-dimensional structures**
   a) read and understand map relations
   b) create accurate cross sections based on surface data
   a) extrapolate surface data to depth
   b) use aerial imagery to interpret broad structures

6) **Place geological structures in a broader tectonic context**
   a) recognize the large-scale stress-strain implications of suites of structures
   b) understand the relationship between stress, strain, and tectonic regimes
   c) demonstrate familiarity with the broad-scale tectonic history of North America

**GOALS FOR BROADER SKILLS (and related outcomes):**
A) Enhance students’ quantitative skills by:
   i) reinforcing skills in practical geometry and trigonometry
   ii) using and manipulating tensors
   iii) real-world application of quantitative concepts in physics
B) Improve students’ ability to work in 3 dimensions by:
   i) learning practical techniques to visualize in 3-D
   ii) practical applications using 2-D images for 3-D interpretation

C) Gain computer skills by:
   i) using Excel to carry out calculations and interpret data
   ii) gaining proficiency in Google Earth

D) Hone field interpretation skills by:
   i) learning how extrapolate from theory to field identification
   ii) learning how to make and record field measurements

E) Practice team building skills and effective communication by
   i) collaborative labs and field exercises

**ASSESSMENT OF ATTAINMENT OF COURSE GOALS:**
Student attainment of course goals is assessed through tests, quizzes, laboratory exercises, and the required field trip throughout the semester. Quizzes are narrowly focused upon specific skills that are necessary for student progress in the course. Tests focus upon the application of those skills, with an emphasis upon synthesizing knowledge with the intention to assess the ability to use specific skills as part of problem solving.
<table>
<thead>
<tr>
<th>GEO 309 Curriculum Assessment Map</th>
<th>Expected Outcomes</th>
<th>1) analyze relations among geometrical features in 3D</th>
<th>2) Interpret geologic maps</th>
<th>3D relate 2D exposures to 3D structures</th>
<th>4) calculate and analyze stress using Mohr circles</th>
<th>5) identify &amp; graphically analyze strain</th>
<th>6) identify &amp; interpret folds, faults, shear zones, joints, cleavage &amp; rock fabric</th>
<th>7) place geological structures in a broader tectonic context</th>
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<td>Assessmet Tools</td>
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