PHYS 369M/PEO 369M: Science of Climbing

Instructor: Prof. Graham Kribs
Office: 477 Willamette Hall
Office Hours: We’ll setup once the class is going.
Slack: https://app.slack.com/client/T01HQ6VK4QN/C01HTT5R1SR
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Class Communication: I will use the Slack channel for all class communication, including announcements, assignments, auxiliary material, and other relevant information.

Class Cancellation: In the unlikely event that I have to cancel class at the last minute (bad weather or otherwise), I will attempt to email everyone.

Course Description

The course is an introduction to the physics and scientific principles behind climbing. No science pre-requisites are required, but students must have completed at least one Outdoor Program climbing course: PEO 251 (Rock Climbing I), or have equivalent experience and permission from the instructor. In the course we’ll use anchor construction to explore how forces work in various dimensions, using vectors, conditions for statics, static versus dynamic load, and breaking strength. In top rope and lead climbing we’ll explore dynamics, including the importance of a dynamic rope, fall factor, effective forces on anchors, gear placement, belayer, etc. We’ll also explore the importance of helmets, cycling versus climbing helmets, and the effect of rapid deceleration on the body and brain. Through rigging and mechanical advantage, we’ll explore pulleys and friction. The emphasis will be on connecting physics to climbing systems, equipment, and techniques through interactive discussions and hands-on demonstrations.

Safety Policies

The following document: https://www.dropbox.com/s/1myia2a8mdnru9c/safety_covid_phys369_winter2021.pdf?dl=0 supplements this syllabus with details regarding Class Safety, Requirements, Expectations, and Policies, COVID Guidelines for In-Person Classes, and the requirement to read, understand, and sign the Statement of Risk, Assumption of Risk, and Release of Liability document that will be provided prior to the first in-person class.
Weekly Schedule

The topics include:

Week 1: Measurements; units; accuracy; precision; interpreting datasheets from manufacturers  
Week 2: Gravitational acceleration; free-fall; one-dimensional forces; peak forces on ropes from deceleration of a dead weight  
Week 3: Climbing free-fall: top-rope falls; lead falls; peak forces on old and new ropes; peak forces with different belay styles  
Week 4: Two-dimensional forces; forces on anchors; narrow versus wide angle; importance of minimal-extension; peak force from anchor failure  
Week 5: Rigging; pulleys; mechanical advantage; forces on rigging anchors  
Week 6: Introduction to equipment failure; working loads; peak loads; maximum loads on climbing equipment  
Week 7: Testing climbing equipment: forces to break tack-bar; carabiner (taped open); harness gear loop; ascender on rope  
Week 8: Helmets: rock fall on climbing helmets; simulated falls with bike helmet drop tests; climber helmet drop tests; velocity on impact from height  
Week 9: Friction: normal forces; static versus dynamic friction; climber shoe friction (old versus new; dry versus wet); rope friction; heat generated; calorimetry measurements  
Week 10: Summary and wrap up; Final presentations

Objectives

The objectives of the course is to gain a deeper understanding of the science and physics beyond climbing and climbing equipment. The course expectations are that you attend every class, complete the reading/writing assignments and give an excellent final project/presentation.

Learning Outcomes

The learning outcomes of the course is to gain a deeper understanding of the scientific principles behind why climbing equipment is designed the way it is to ensure the safety of climbers. This involves gaining an understanding of some basic mechanics, static versus dynamic loading, how measurements are made, how to measure forces, units and unit conversion, reading and understanding manufacturer descriptions for breaking strength limits of climbing equipment. Students should also gain a scientific understanding why “safe” climbing anchors involve redundancy, no extension, and load balancing.

Workload

Reading/Writing Assignments: Each week students will be given reading material that enables
and supplements the lecture material. Reading references will be include original manufacturer information; manufacturer websites; books; original articles; and other sources. The goal of each week’s assignment is to synthesize what the students have learned from the reading and lecture presentation in a coherent report. The report should include what was done in the previous class, what things they already knew, what they learned, what was still confusing, what demonstrations worked, and what didn’t work. The report will also include a comparison of the lecture presentations with the reference material. The purpose is to reflect on how the class and reference material helped illustrate why various aspects of climbing are done the way they are, or why equipment is designed in a particular way (or to a particular tolerance). Anticipate 2 hours per week.

Final presentation: Students will select a final project that involves researching a particular topic relevant to climbing in the scientific literature. Examples include: knot breaking strength using color-coded tension fibers; metallurgy of bolts; geology of rock that is climbed (basalt; limestone; granite; etc.). Students will write up their project and give a brief final presentation to the class during week 10 of classes. Anticipate 20 hours spread over the last 4 weeks of classes to find a topic, research the topic, interpret the science, apply the science to climbing, write up the topic, and prepare the final presentation.

Grading Policy

Your grade is determined by your weekly writing assignments (80% of grade) and your final project/presentation (20% of grade).

Writing assignments:
A-level grade: All of the writing assignments are clear, detailed, appropriate length, and have been turned in on time.
B-level grade: Most of the writing assignments are clear, detailed, appropriate length, and have been turned in on time. No more than one learning review was not turned in / incomplete.
C-level: Some of the writing assignments are clear, some were incomplete. No more than one learning review was not turned in.
D-level: Most writing assignments were unclear or incomplete. No more than two writing assignments were not turned in.
Fail: Three or more writing assignments not turned in; other learning reviews unclear or incomplete.

Final project/presentation:
A-level grade: Project write-up and presentation is clear, well-organized, understandable, and questions during presentation are adequately addressed.
B-level grade: Project write-up and presentation is mostly clear, organized, understandable but with some issues, and questions during presentation are partially addressed.
C-level grade: Project write-up and presentation is somewhat clear, not well organized, not easily understandable by other students, and most questions during presentation cannot be answered.
D-level grade: Project write-up and presentation is not clear, not well organized, not understandable by other students, and questions during presentation cannot be answered.
Fail: Project write-up is missing OR presentation was not completed.
Accessible Education Statement

The University of Oregon is working to create inclusive learning environments. Please notify me if there are aspects of the instruction or design of this course that result in disability-related barriers to your participation. You are also encouraged to contact the Accessible Education Center in 360 Oregon Hall at 541-346-1155 or uoaec@uoregon.edu.

Academic Misconduct Statement

The University Student Conduct Code (available at conduct.uoregon.edu) defines academic misconduct. Students are prohibited from committing or attempting to commit any act that constitutes academic misconduct. By way of example, students should not give or receive (or attempt to give or receive) unauthorized help on assignments or examinations without express permission from the instructor. Students should properly acknowledge and document all sources of information (e.g. quotations, paraphrases, ideas) and use only the sources and resources authorized by the instructor. If there is any question about whether an act constitutes academic misconduct, it is the students’ obligation to clarify the question with the instructor before committing or attempting to commit the act. Additional information about a common form of academic misconduct, plagiarism, is available at https://researchguides.uoregon.edu/citing-plagiarism.