ENGRI/CEE 1160 Modern Structures
Syllabus – Fall 2023

Instruction Mode: In Person
Credit Hours: 3
Class Meeting Times: Tuesdays and Thursdays, 10.10am-11.25am
Location: Phillips Hall 403

Instructor: Prof. Chloé Arson
Office: Hollister Hall 373
E-mail: cfa36@cornell.edu
Office hours: Tuesdays and Wednesdays 1.30pm-2.30pm via Zoom:
https://cornell.zoom.us/j/91225582235?pwd=RW1uM0ltU2VjTit2UVdFZkJZWlRmQT09
or by appointment

Teaching Assistant: Bassel Khoury
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Office hours: TBD

Course description: A hands-on introduction to structural engineering, combining classroom demonstrations and presentations with laboratory experience. Students predict hurricane wind forces and design key elements in a high-rise building to resist those forces. Students design a residential wood-deck based on laboratory tests to stretch, compress, shear, split, and bend wooden specimens. Students build brick walls and fail them under simulated hurricane and tornado wind pressures, weld steel bars and pull them apart, and forensically examine the failures. Students use software to analyze and design steel truss bridges, and become proficient at using spreadsheets to perform routine structural calculations and graph the results. Students become familiar with structural concrete by designing, building and testing small scale reinforced-concrete frames to resist large dynamic forces.

Course rationale and scope: This course is built on the theme of emergency response to natural hazards (e.g., landslides, floods, wildfires) and security threats (e.g., wars, terrorist attacks). Various facets of civil engineering (e.g., structural design, geotechnical engineering, hydraulics, construction management, transportation) will be illustrated from case studies of structural collapse, environmental disasters, and network outage. Lectures will be organized as forensic investigations. Students will study evidence in groups, using a variety of tools to analyze the data, including hand calculation, computer programs and large language models (including ChatGPT). Groups will compare their interpretations via class discussions and test their hypotheses through hands-on experiments, for which students will prepare specimens, weld parts, build a masonry wall, and record displacement and load measures. By constructing several types of levers, students will be introduced to the fundamental principles of static equilibrium, discover how to calculate internal forces in structures and use these calculations to predict failure and design repairs. The interaction between the built and natural environments will be analyzed through the lens of granular media. Anchor systems will be 3D printed and tested for pullout resistance to highlight the importance of particulate flow in soil resistance, and flow nets will be drawn to interpret flash floods. Because post-disaster reconstruction requires communication, energy and transportation, the last part of the course will be dedicated to infrastructure network resilience and accessibility.

Note that the scope of the Fall 2023 version of ENGRI 1160 will be broader than in previous offerings, because class activities will not be limited to structural engineering. As a result, some of the engineering mechanics experiments that were conducted in past semesters will be replaced by hands-on activities in

geotechnical engineering and transportation engineering. Also note that this class emphasizes civil engineering (in particular, engineering mechanics) over environmental engineering (for example, chemical reactions combined with fluid flow). However, the course will be framed around big challenges and problems that are faced by both civil and environmental engineers.

Learning Outcomes: By the end of the semester, undergraduate students will gain skills to:

- analyze infrastructure failures through mechanical principles;
- build and test model structures in the laboratory;
- design structural repairs;
- synthesize forensic evidence to interpret case studies of catastrophic failure;
- recommend civil engineering mitigation plans after a natural or human-induced disaster;
- engage in teamwork.

Prerequisites: Previous knowledge and experience in calculus and physics are recommended, but not required, and may be helpful for success in this course.

Bibliographic and media resources: The course is based on a variety of textbooks, manuals, articles, and other references. Although students will not be graded on reading assignments, some resources (e.g., articles, videos, tutorials) may be suggested during the semester to help with some graded reports and enhance the learning experience. All course resources will be available on Canvas.

Computing resources: Some classes will require the use of a computer for non-graded activities as well as graded assignments. For the students who cannot or do not wish to bring a personal computer to class, it is possible to borrow a laptop at Olin and Uris libraries (https://olinuris.library.cornell.edu/equipment) or at Mann library (https://mann.library.cornell.edu/laptops-equipment). I will announce the dates when a laptop is needed for class at least a week in advance and I will provide instructions to install any software needed for the class activities.

Course outline: Note that schedule changes may occur depending on the availability of laboratory space and equipment. Any schedule change will be announced at least a week early in class and on Canvas. The class will be divided into two cohorts during the weeks that have a lab component. Cohort 1 will attend the lecture on Tuesday and conduct the lab experiments on Thursday. Cohort 2 will conduct the lab experiments on Tuesday and attend the lecture on Thursday.

Week	Date	Topic
1	08/22	**Lecture:** Introduction to civil engineering. Civil engineering in response to natural and human-induced disasters. Principles of equilibrium (1/2). Use of principles of equilibrium to interpret infrastructure failures.
	08/24	**Lecture:** Principles of equilibrium (2/2). Concept of force. Concept of moment. Application to the design of post-disaster debris removal devices.
2	08/29	**Lecture:** Lever design by sketch, hand calculation and structural engineering software.
	08/31	**Lab #1:** Equilibrium of levers for various weight and height lifts.
3	09/05	**Lecture:** Example of the collapse of the Rana Plaza building in Savar, Bangladesh, due to the failure of tension/compression members. Introduction to bars and trusses. Hand calculations and computer analysis.
	09/07	**Lab #2**: Tension and compression of steel axial members.

Week	Date	Topic
4	09/12	**Lecture:** Examples of Bailey bridges for emergency response. Hand calculations and computer analysis.
	09/14	**Lab #3:** Steel welding. **Smaller lab groups, scheduled outside normal lecture hours.**
5	09/19	**Lecture:** Examples of catastrophic welding failures. The lost Oceangate submersible case. Average normal force vs. local force. Force concentrations. Axial force / displacement and stress / displacement curves.
	09/21	**Lab #4:** Weld testing and forensic analysis.
6	09/26	**Lecture:** Examples of infrastructure collapse due to earthquakes, e.g., the 1989 Loma Prieta Earthquake. Principle of soil liquefaction. Introduction to shear deformation. Examples of seismic foundations.
	09/28	**Lab #5:** Wood testing in compression and shear, at various orientation to the grain.
7	10/03	**Lecture:** Examples of structural failure by excessive flexion (e.g., 1995 Sampoong Department Store Collapse) and by buckling (e.g., 1967 Silver Bridge collapse). Introduction to bending deformation and bending internal forces and moments.
	10/05	**Lab #6:** Flexion of wooden beams and buckling of wooden columns.
8	10/10	No lecture – Fall Break
	10/12	**Lecture:** Example of structural failure due to temperature changes: rail track buckling, bridge deck buckling at launch, and the Space Shuttle Challenger explosion. Introduction to thermal deformation and thermal internal forces.
9	10/17	**Lecture:** Introduction to blast mechanics. Examples of concrete failures by explosion, e.g., the 2020 Beirut Port explosion. Composition of cement and concrete. Principle of steel-reinforcement in concrete.
	10/19	**Lab #7:** Brick wall construction.
10	10/24	**Lecture:** Homogenization of periodic structures. Calculation of brick wall mechanical properties. Homogenization calculations for polycrystalline materials.
	10/26	**Lab #8:** Brick wall resistance test.
11	10/31	**Lecture:** The Oso mudslide and other examples of landslides. Introduction to particulate mechanics and soil shear strength.
	11/02	**Lab #9:** Multi-blade anchor 3D printing.
12	11/07	**Lecture:** Internal forces and stresses. Application to geostatic stress in soil. Arching effects. Bio-inspired design of complex tunnel systems in dry substrate.
	11/09	**Lab #10:** Anchor pullout tests in dry sand.
13	11/14	**Lecture:** Forensic interpretation of flash floods. Soil porosity and permeability.
	11/16	**Lecture:** Forensic interpretation of earth dam failure. Flow nets.
14	11/21	**Lecture:** The leaning of the Pisa and Millennium Towers. Soil consolidation.
	11/23	No lecture – Thanksgiving Break
15	11/28	**Lecture:** Case studies of major network outages: 2003 Northeast blackout, 2021 Texas winter storm. Network resilience analysis. Mitigation of network disruptions.
	11/30	**Lecture:** Transportation and accessibility. Policies and technologies.
Final meeting		A final meeting will be organized during the final exam period (December 8-16). The final meeting will be 2.5 hours long and will include final project presentations.

Assignments: Student assessment will be based on problem worksheets, laboratory reports, self- and peer-evaluations, quizzes, and a final project presentation. Guidelines and grading rubrics will be provided for each assignment.

Problem worksheets: Some lecture time will be devoted to group work on structural analysis, forensic interpretation and mitigation planning. Groups will report their answers and explain their rationale in a worksheet that will contain technical information, guidance, and questions. The same worksheet grade will be given to all students of the group. Some of the graded group activities will require the use of a computer (see the statement above regarding computing resources for this class).

Laboratory reports: Safety procedures and testing protocols will be explained before each laboratory activity. You will work in groups to complete the lab work, such as specimen preparation, test set up, measurement recording, interpretations. Groups will dispose of a log sheet to report their measurement readings. After each lab, you will have to write a report as a group and upload it to Canvas before specific deadlines indicated below. The report shall explain the lab procedure, present the measurement logs, describe the results, and interpret the experiments. To guide you in your interpretations, dedicated questions and rubrics will be provided for each lab report assignment. Students of a same group will receive the same lab report grade. If there is anything that prevents you from performing one of the tasks planned for the labs (e.g., lifting weights), please contact me and we will work on a modified lab task for you.

Self- and peer-assessments: You will be asked to write learning assessments about yourself and about your group members after class time to reflect on group activities done during lecture time or during the lab periods. Rubrics will be provided to evaluate inquiry and analysis, problem solving, critical thinking, and teamwork. You will receive a learning score based on the assessments made by your peers on your group contributions. I will provide you with a critiquing score based on the quality of your self- and peer-assessment comments, which I will evaluate with dedicated rubrics made available to the class. You will receive a grade that will reflect your learning and critiquing scores. Peer- and self-assessments will only be read by my Teaching Assistant and myself. To encourage honest and respectful feedback while preserving anonymity, you will have access to a summary of the comments made by your peers on your group contributions, but you will not be given the verbatim comments written in the peer assessments or to the names of the students who wrote the comments. Self- and peer- assessments are to be uploaded on Canvas by the deadlines given below.

Quizzes. Quizzes are strictly individual assignments that aim to test your comprehension of the mechanical concepts and methods of analysis presented in class. Quizzes given during class will typically take 15 to 20 minutes. They will be closed book and will comprise multiple-choice questions, and/or short problems that require sketching, calculation, analysis and/or interpretation. Online quizzes will be open book and will be available through Canvas “Quizzes” function. Online quizzes will typically be available for 24h on Canvas. You will have a single attempt of 20 minutes to complete each online quiz. Online quizzes will comprise True/False questions, multiple choice questions and short problems that require a unique numerical answer. Although online quizzes will not be proctored, I will ask that you attest that you completed each online quiz on your own, and that you comply with the academic honesty statement below.

Final project presentation. You will work in groups to analyze a case of infrastructure failure and propose a remediation plan. I will provide example case studies, and you will deliver a final presentation of your work during the final class meeting period. The slides will be due the day before the presentation. Each group will need to upload their slide deck on Canvas. A presentation template and grading rubrics will be posted on Canvas. The same project grade will be given to all group members.

Student achievement assessment:

Class worksheets 20% (5 worksheets @ 4% each)

1. Bailey bridge analysis: on 09/12 (groups of cohort 1) or 09/14 (groups of cohort 2)
2. Seismic foundation design: on 09/26 (groups of cohort 1) or 09/28 (groups of cohort 2)
3. Overheated bridge deck launch failure: on 10/12
4. Flash flood forensic analysis: on 11/14
5. Network resilience assessment: on 11/28

Lab reports: 35% (7 reports @ 5% each)

1. Report of Lab #1 due on 09/07
2. Report of Lab #2 due on 09/14
3. Report of Labs #3 and #4 due on 09/28
4. Report of Lab #5 due on 10/05
5. Report of Lab #6 due on 10/19
6. Report of Labs #7 and #8 due on 11/02
7. Report of Labs # 9 and #10 due on 11/16

Self- and peer- assessments: 16%

1. Assessment of yourself and 2 team-members of your choosing at mid-term: due on 10/05
    - Learning score (based on feedback received from others): 4%
    - Critiquing score (based on your feedback to others): 4%
2. Assessment of yourself and 2 team-members of your choosing at end of term: due on 11/21
    - Learning score (based on feedback received from others): 4%
    - Critiquing score (based on your feedback to others): 4%

Quizzes 24% (4 quizzes at 6% each)

1. Quiz #1 on 09/15 – online open book
2. Quiz #2 on 10/20 – online open book
3. Quiz #3 on 11/16 – in class closed book
4. Quiz #4 on 11/30 – in class closed book

Final project presentation during final exam period (Dec. 8-16): 5%

Grading scale

98-100% A+	88-89% B+	78- 79% C+	60-69% D
93-97% A	83-87% B	73-77% C	below 60% F
90-92% A-	80-82% B-	70-72% C-	

Course expectations

Attendance. Class attendance is an expectation. Once a student has reached three unexcused absences, a penalty of 1% on the course grade will be applied for each unexcused absence.

In-class participation. Class presence and participation are an expectation. Active class participation and discussion are encouraged. During class, you are expected to use electronic devices for coursework alone and interact with the other students in a professional manner.

Personal conduct. The Program expects students to be respectful and professional in all participation and communication. You are expected to maintain professional conduct and speech in all aspects of this course. Professional behavior demands you have a responsible and mature attitude in person and online.

Disrespectful, unethical, and/or unprofessional behaviors will not be tolerated and can result in course failure and/or dismissal from the program.

Communication policy. You may use the discussion forum available in Canvas (Ed Discussion) to discuss the course content and ask questions. The teaching assistant and/or I will respond. Your classmates will see the Q&A and they will be able to participate in the discussion as well. You are encouraged to ask questions during class time or during office hours. Due to the large flow of emails that I receive daily, it is best to ask me questions by email only if you have exhausted your options to ask questions in class, during office hours or via Ed Discussion. If you send an email to the teaching assistant or to me, please expect a response within 2 or 3 business days. Any question regarding the laboratory activities may be addressed to the teaching assistant. I will address any question regarding other course contents.

Late assignment policy. Online quizzes, lab reports, self- and peer- evaluations, and presentation slides are to be submitted electronically on Canvas by the dates and times indicated above. Late assignments will not be accepted unless an extension is requested ahead of time. Extensions will be considered in special cases and must be requested at least a week before the due state. Unless you requested an extension because of an emergency that you could not have anticipated and is beyond your control, a penalty of 5% will be applied per day after the deadline.

Make-up assignment policy. Problem worksheets and closed book quizzes will be collected in class. Make-up problem sets and quizzes will only be arranged for students who can present a valid excuse for missing class.

Academic Integrity Statement. By enrolling in this course, each student assumes the responsibilities of an active participant in Cornell University's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. Students are urged to read and complete the exercises on "Recognizing and Avoiding Plagiarism" at: https://plagiarism.arts.cornell.edu/tutorial/index.cfm . For more information, refer to: https://theuniversityfaculty.cornell.edu/dean/academic-integrity/

Inclusivity/Diversity Statement. I consider the classroom (physical or virtual) to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. Diversity is essential to build innovation, creativity, and growth into our classrooms. Towards this end, contributions are valued regardless of identity, culture, background, experience, status, abilities, and opinion. Refrain from expressing disrespect towards any group or individual. Inclusiveness is imperative to the pursuit of excellence in research, teaching, and outreach. For more details on diversity and inclusion, please refer to the following website: https://diversity.cornell.edu

Inclusive Learning Environment. Cornell supports an inclusive learning environment where diversity and individual differences are understood, respected, appreciated, and recognized as a source of strength. It is expected that students in this class will respect differences and demonstrate diligence in understanding how other peoples' perspectives, behaviors, and worldviews may be different from their own. Please see the original statement from the University of Northern Colorado's College of Education

and Behavioral Science: https://www.unco.edu/education-behavioral-sciences/about-us/diversity-equity/framework.aspx

Safe Zone Statement: I am a member of a Safe Zone Ally community network, and I am available to listen and support you in a safe and confidential manner. As a Safe Zone Ally, I can help you connect with resources on campus to address problems you may face that interfere with your academic and social success on campus as it relates to issues surrounding sexual orientation and gender identity. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. My goal is to help you be successful and to maintain a safe and equitable campus.

Disabilities Statement. Cornell University is committed to ensuring access to learning opportunities for all students. Student Disability Services (SDS) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.

- If you are registered with SDS and have a faculty notification letter for this semester, please contact me early in the semester to review how the accommodations will be applied in the course. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances, so arrangements can be made. If you have an immediate access need, please see me after class.
- If you have, or think you may have, a disability, please contact the SDS office to arrange a confidential discussion regarding equitable access and reasonable accommodations.
- Students with short-term disabilities, such as a broken arm, can often work with instructors to minimize classroom barriers. In situations where additional assistance is needed, students should contact the SDS as noted above.
- If you are registered with SDS and have questions or concerns about your accommodations, please contact your SDS Counselor.

Students are advised to contact SDS as early as possible in the semester to ensure appropriate accommodations: Cornell Health Level 5, 110 Ho Plaza, 607-254-4545, www.sds.cornell.edu

Attestation. By registering for this class and accessing course materials through Canvas, students agree to abide by University, College, Department, and Course policies.