CIV E 664 Introduction to Solid Mechanics

Fall 2025 - September 03 to December 08

Class time: Wednesday 11:00-13:50 Location: NRE 2-080

Instructor:

Bo Zhang, PhD, P.Eng, he/him/they
No office phone, contact through emails
bzhang7@ualberta.ca
Donadeo Innovation Centre For Engineering 6-239
Office Hours: By appointment through emails

Course Description:

*3 (fi) (either term, 3-0-0) Fundemental knowledge: Vector, Tensor, Stress, Strain, Constitutive laws for elasticity, plasticity, flow rule, hardening rules, limited theorem, heterogeneity and upscaling. Skillsets: Using python to solve solid mechanics problems, and FLAC3D

Prerequisites: N/A

Course synchronous and asynchronous content delivery schedule:

- Course materials will be provided on Canvas. Assignment and project submission will be through Canvas.
- Lectures will be in-person 60 minutes, 50 minutes break/Q&A and 60 minutes.
- In-person lectures will NOT be live-streamed or recorded; therefore in-person attendance is highly recommended.
- Online lecture(s) may be arranged under extenuating circumstances.

Land Acknowledgment:

The University of Alberta respectfully acknowledges that we are located on Treaty 6 territory, a traditional gathering place for diverse Indigenous peoples including the Cree, Blackfoot, Métis, Nakota Sioux, Iroquois, Dene, Ojibway/ Saulteaux/Anishinaabe, Inuit, and many others whose histories, languages, and cultures continue to influence our vibrant community.

TA Information:

Xuehan (Han) Yin, xuehan3@ualberta.ca

Course Objectives & General Content:

1. Introductory linear algebra: Linear vector spaces, vector transformation, Cartesian tensors, vector calculus.
2. Stress: The stress tensor, Cauchy stress tenor, equilibrium equations, principal stresses, stress invariants, stress deviator tensor, Piola-Kirchhoff stress tensors.
3. Strain: Infinitesimal normal and shear strains in two dimensions, infinitesimal strain and rotation tensors, transformation of the infinitesimal strain tensor, volumetric strain, principal strains, strain invariants, strain deviator tensor, Lagrangian and Eulerian large strain tensors.

4. Constitutive equations for linear elasticity: generalized Hooke’s law, reduction in elastic constants due to isotropy, Lamé’s constant, bulk modulus, elastic anisotropy
5. Compatibility equations
6. Elasticity problems in 2D
7. Theory of plasticity: Yield function, flow rule, Drucker's postulate, elasto-plastic constitutive relationship
8. Plasticity problems
9. Limit theorems: Principle of virtual displacement, uniqueness theorem, extremum principles
10. Coding for problems solving in solid mechanics
11. Using FLAC3D for developing upscaling techniques for elastic and plastic behavior

Learning Outcomes:

By the end of this course, students should be able to:

1. Demonstrate an understanding of the basic principles behind the transformation of stress, theory of elasticity and plasticity
2. Apply the theory of elasticity and plasticity in engineering design and problem solving by coding and simulation
3. Demonstrate the ability to work and communicate effectively in a collaborative engineering project, and deliver in a final report and presentation

Marking Scheme:

Activity	(A)Synchronous	Due/Scheduled	Weight
Assignments		According to course schedule table	30%
Midterm Presentation		October 8	10%
Term Project		December 3	30%
Final Exam		December 10	30%

The Faculty recommended grade point average for a 600 level course is 3.3.Instructors have the leeway to deviate from this average and can assign grades based on their own scheme. All grades are approved by the department chair (or delegate). The office of the Dean has final oversight on all grades.

Term Work

All term work solutions will be posted no later than the last day of classes. All term work will be returned to students by the final day of classes, with the exception of major term work due in the last week of classes. The latter will be returned by the day of the final examination or the last day of the examination period if there is no final examination in the course as per university policy; instructors will make accommodations to return these term work. It is the responsibility of the student to pick up all their term work at the specified time and place. Any unreturned term work, shall be retained and then shredded six months after the deadline for reappraisal and grade appeals. Final examinations will be kept for one year as required by university guidelines and the Government of Alberta's Freedom of Information and Protection of Privacy Act.

Calculator Policy

There is no calculator policy in this course; students are free to use the calculator they wish for all assessments.

Expectations for AI use

On the first day of class, we will as a community co-create an agreement identifying expectations on the use of AI tools that ensures everyone: 1) understands the benefits and limitations of the tools, 2) is able to differentiate between appropriate and inappropriate uses, 3) has equal access to such tools, and 4) is clear on the University of Alberta's relevant policies and procedures.
The Community of Learners agreement will align with the University of Alberta's academic integrity policies and procedures (See relevant section on cheating in University of Alberta (November 2022) Code of Student Behaviour). As necessary, we will agree to revisit and reconsider aspects of the agreement throughout the course to ensure all members of the course's Community of Learners continue to have the required shared understanding of the expectations for AI tool use in this class.
Important: Any and all use of AI and AI tools in assessment tasks must be transparently and honestly identified and referenced as directed. Follow-up reflection assignments explaining AI use must be completed and uploaded to eClass assignments within one (1) day of major assessment task completion.

Text and References (Mandatory):

Lecture notes, will be available in PDF via Canvas.
Class notes by Dr. Hrudey (Topics 1-6)
Online supplementary course notes are highly recommended:
https://engcourses-uofa.ca/books/introduction-to-solid-mechanics/

Website:

Canvas

Did you know that the University of Alberta has various low-to-no-cost services to help students succeed? Visit http://www.deanofstudents.ualberta.ca/ for information about the academic, wellness, and various other support services available to U of A students. It's never too early or too late to seek help!

Tentative Course Schedule

Date	Topic	Assignments (release / due)
Sep 3	• Introduction, Review (Vector space, Tensor)	Assignment 1 (Sep 10 / Sept 24)
Sep 10	• Python Introduction (Bring your laptop, set you **Github**, start a project of CIV E 664, install **Codespaces** and **Python extension** before lecture) • Stress	
Sep 17	• Strain	
Sep 24	• Constitutive laws for elasticity and compatibility equations	
Oct 01	• Elasticity problems in term project (Bring you laptop, install **FLAC3D** 7.0 before lecture)	Assignment 2 (Sep 17 / Oct 1)
Oct 08	• Midterm Presentation (Your project and solid mechanics) • Term project team assemble, Q&A	Midterm Presentation due (Oct 8)
Oct 15	• FLAC3D Introduction (Online, Link)	
Oct 22	• Theory of plasticity	
Oct 29	• Flow rule, hardening rule, Plasticity problems in term project	Assignment 3 (Oct 8 / Oct 29)
Nov 5	• Heterogeneity and Upscaling of elastic&plastic properties	
Nov 12	• Limit theorem • Q&A for term project	
Nov 19	• Q&A for term project	
Nov 26	• Application of machine learning in solid mechanics and upscaling • Q&A for term project	
Dec 3	• Term project presentation	Term project due (Dec 3)
Dec 10	• Final Exam (48 hours)	

University and faculty policies

Respect and professionalism

The Faculty of Engineering is committed to fostering and protecting an equitable, inclusive, and respectful work and study environment in line with University of Alberta policies and professional engineering industry standards.

The faculty prepares students to uphold industry standards to become a Professional Engineer (P.Eng). Therefore, respect, professionalism, and accountability must be upheld within the Faculty of Engineering and the University of Alberta.

Academic integrity and student conduct

The University of Alberta is committed to the highest standards of academic integrity and honesty, as well as maintaining a learning environment that fosters the safety, security, and the inherent dignity of each member of the community, ensuring students conduct themselves accordingly. Students are expected to be familiar with the standards of academic honesty and appropriate student conduct, and to uphold the policies of the University in this respect.

Students are particularly urged to familiarize themselves with the provisions of the Student Academic Integrity Policy and the Student Conduct Policy, and avoid any behaviour that could

potentially result in suspicions of academic misconduct (e.g., cheating, plagiarism, misrepresentation of facts, participation in an offence) and non-academic misconduct (e.g., discrimination, harassment, physical assault). Academic and non-academic misconduct are taken very seriously and can result in suspension or expulsion from the University.

All students are expected to consult the Academic Integrity website for clarification on the various academic offences. All forms of academic dishonesty are unacceptable at the University. Unfamiliarity of the rules, procrastination or personal pressures are not acceptable excuses for committing an offence. Listen to your instructor, be a good person, ask for help when you need it, and do your own work -- this will lead you toward a path to success. Any academic integrity concern in this course will be reported to the College of Natural and Applied Sciences. Suspected cases of non-academic misconduct will be reported to the Dean of Students. The College, the Faculty, and the Dean of Students are committed to student rights and responsibilities, and adhere to due process and administrative fairness, as outlined in the Student Academic Integrity Policy and the Student Conduct Policy. Please refer to the policy websites for details on inappropriate behaviours and possible sanctions.

The College of Natural and Applied Sciences (CNAS) has created an Academic Integrity for CNAS Students eClass site. Students can self-enroll and review the various resources provided, including the importance of academic integrity, examples of academic misconduct & possible sanctions, and the academic misconduct & appeal process. Students can also complete assessments to test their knowledge and earn a completion certificate.

"Integrity is doing the right thing, even when no one is watching." -- C.S. Lewis

The Faculty of Engineering expects an environment free of harassment, discrimination, and bullying. We encourage you to talk to the Office of Safe Disclosure and Human Rights about experiences, questions, or concerns. Additional resources and support for students are attached below.

Engineering students studying in the province of Alberta must also follow the Code of Ethics set by the Association of Professional Engineers and Geoscientists of Alberta (APEGA).

Course outline policies, course requirements, evaluation and grading information can be found in the University Calendar.

Safety during learning activities

In all Faculty of Engineering courses, labs, seminars or other learning activities, safety is of paramount importance. In some cases, laboratory work in a program requires high standards for risk management to keep potential hazards safely under control.

Anyone found to be unable to function safely in the class, lab, seminar or other learning activity may be asked to leave or be removed for their and the safety of other participants and instructors in alignment with the Student Academic Integrity Policy and Student Conduct Policy. As members, or prospective members, of the engineering profession, it is your responsibility to identify and inform the proper authorities of unsafe work.

Audio and video recording

Audio or video recording, digital or otherwise, of lectures, labs, seminars or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan.

Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

Only those items specifically authorized by the instructor may be brought into the exam facility. Students must not bring any unauthorized electronic device into an examination room, including cell phones or other devices.

Student services and support

Health & Wellness Support

Counselling and Clinical Services

Free, short-term, appointment-based counselling and psychiatric services. Also offers drop-in workshops. Book an initial consultation. Visit uab.ca/CCS to learn more.

Wellness Supports Social Workers

Free one-on-one support for students in the areas of housing, finances, academics, personal wellness, life skill development, family dynamics, system navigation, and any area of life where there is a desire to invite change. Visit uab.ca/wellness to learn more.

Sexual Assault Centre

Free, anonymous, and confidential drop-in counselling. Visit uab.ca/UASAC to learn more.

The Office of Safe Disclosure & Human Rights (OSDHR)

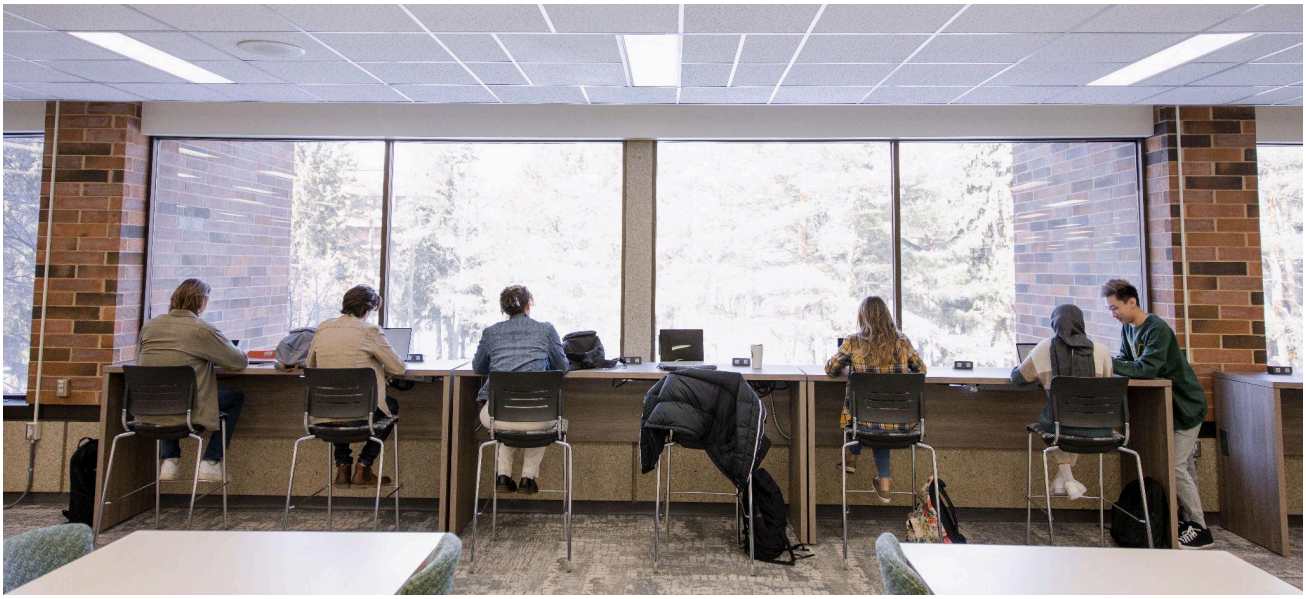
The OSDHR advises confidentially on sensitive issues you may not feel comfortable solving on your own. Contact the OSDHR if you want to get help or to make a report while keeping your privacy. Visit uab.ca/OSDHR to learn more.

HIAR (Helping Individuals at Risk)

If you're worried about someone, contact HIAR, who can help assess risk and connect individuals to support. Learn more at uab.ca/HIAR.

Immediate External Supports

Health Link Alberta: 811
Suicide Crisis Helpline: 988



Academic support

Academic Success Centre
Access to a variety of services to maximize your academic success. Learn more at uab.ca/ASC.

Accessibility Resources
Connects students with disabilities to accommodations. Learn more at uab.ca/Access under accommodations + accessibility.

Decima Robinson Support Centre
Academic support for 100- or 200-level introductory calculus, linear algebra and statistics courses. Visit uab.ca/DSC to learn more.

Engineering Student Success Centre
The Faculty of Engineering provides drop-in tutoring for first-year courses. Visit uab.ca/ESSC to learn more.

Office of the Student Ombuds
Call for complex problems and conflict mediation. Learn more at uab.ca/ombuds.

Financial support

Student Service Centre

For awards and other funding support. Learn more at uab.ca/ask.

Campus Food Bank

The Campus Food Bank Society is an independent charity supporting University of Alberta students, faculty, staff, and alumni for up to five years. For additional information visit their website at campusfoodbank.com.