CIVIL-425

Continuum mechanics and applications

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Cursus	Sem.	Type
Civil Engineering	MA2, MA4	Opt.
Civil engineering minor	E	Opt.
Mechanical engineering	MA2, MA4	Opt.
Mechanics		Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	Oral
Workload	180h
Weeks	14
Hours	**5 weekly**
Lecture	3 weekly
Exercises	2 weekly
Number of positions	

Summary

This course covers the fundamentals of continuum mechanics theory at the graduate level and provides modern examples of applications. Extra emphasis is on emerging data-driven approaches. It is adequate for students with a background in civil, mechanical or material engineering.

Content

The goal of this course is to provide a rigorous introduction to the theory of continuum mechanics. It is based on the content of classical textbooks of continuum mechanics such as Malvern's. The course is offered at the level of graduate course and gives a solid theoretical basis for students aiming to master theory and numerical modeling. It is divided in two modules. The first part covers the fundamentals of continuum mechanics: kinematics of deformation (finite kinematics), conservation laws (lagrangian and eulerian form) of mass, linear and angular momentum balance, principle of virtual work, first and second law of thermodynamics. The second module covers material constitutive theory and applications, including linear and non-linear elasticicity, visco elasticity, plasticity, Newtonian and non-Newtonian fluids and porous media. During both modules, mention to relevant novel data-driven methods in mechanics will be made.

Keywords

Mechanics, continuum, data-driven, physics-informed, constitutive laws

Learning Prerequisites

Required courses

Continuum mechanics (e.g. CIVIL-225), Finite Elements (e.g. CIVIL-321)

Important concepts to start the course

Linear algebra, tensor analysis, numerical analysis

Learning Outcomes

By the end of the course, the student must be able to:

- Conceptualize and formalize a boundary value problem in continuum mechanics.
- Master the fundamental principles of continuum mechanics: describing movement, flow and deformations, applying fundamental balance laws and principles to continua, making modeling choices to poperly describe material response (either with closed-form mathematical models or with data-based physics-informed approaches.

Transversal skills

- Communicate effectively, being understood, including across different languages and cultures.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Demonstrate the capacity for critical thinking
- Make an oral presentation.
- Access and evaluate appropriate sources of information.

Teaching methods

3 hours lectures - either ex-cathedra or to discuss course notes for the week would need to be read prior to the class.
3 hours in exercise room or at home for homework - focused on the resolution of a problem previously described during the lecture.

Expected student activities

Student will be expected to be pro-active and read course material in advance. They will also need to finalize by themselves the solution of the problems given every week.

Assessment methods

During the semester
1 class presentation (analysis of a particular problem/application of continuum mechanics) (30% of the grade)
Oral exam (70% of the grade)

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes
Others	

Resources

Virtual desktop infrastructure (VDI)

No

Notes/Handbook

https://epfl.swisscovery.slsp.ch/permalink/41SLSP_EPF/1g1fbol/alma990005736600205516

Moodle Link

- https://go.epfl.ch/CIVIL-425

Prerequisite for

analysis of mechanical systems that undergo large deformation states, taking decisions as to modeling of complex materials