EPFL

ME-437

Advanced solid mechanics

Curtin William

Cursus	Sem.	Type
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.
Mechanics		Opt.

Language of teaching	English
Credits	5
Withdrawal	Unauthorized
Session	Winter
Semester	Fall
Exam	During the semester
Workload	150h
Weeks	14
Hours	**5 weekly**
Courses	3 weekly
Exercises	2 weekly
Number of positions	

It is not allowed to withdraw from this subject after the registration deadline.

Summary

This course will cover major topics of importance and value for the application and understanding of Solid Mechanics, aiming especially at the micromechanical analyses of problems that connect small scale phenomena to macroscopic engineering performance.

Content

The course will be topical but evolving in a natural flow. Topics will include:
Anisotropic Elasticity: beyond isotropic elasticity
Homogenization methods: the connection between microstructure of a material and the macroscopic effective properties that can be used in continuum analyses
Laminate theory: the special case of fiber composites as layered anisotropic materials, connecting fiber/matrix properties to macroscopic structural response.
Inclusions and Eshelby analysis: stresses and strains around particles embedded in a matrix and undergoing transformations that affect functional performance and failure, with connections to homogenization theory.
Fracture mechanics: basic understanding of the driving forces for crack growth, from both energy and stress perspectives, with advanced concepts for implementation in numerical methods.

Keywords

Mechanics, Elasticity, Homogenization, Laminate theory, Composites, Fracture, Contact, Dislocations, Applied Mechanics, Theory, Computational Mechanics

Learning Prerequisites

Required courses

ME-331: Solid Mechanics, or equivalent course using tensor-based mechanics analyses

Important concepts to start the course

Definitiions of stress and strain
Mechanical equilibrium
Isotropic elasticity (Hooke's Law)
Boundary value problems in small-strain elasticity
Second-rank tensors: properties and applications in mechanics

Index notation

Learning Outcomes

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

- Estimate elastic moduli of two-phase materials
- Analyze stress and strains around inclusions
- Compute stresses in laminated structures
- Integrate concepts for failure
- Design materials/microstructures with specified properties

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Use a work methodology appropriate to the task.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Demonstrate the capacity for critical thinking
- Write a scientific or technical report.

Teaching methods

Lectures on mechanics theory
Examples to illustrate theory and application
Exercises for cementing and applying new knowledge
Course will include project in each of the main course topics

Expected student activities

In-class participation
Collaborative problem solving
Execution of projects

Assessment methods

Graded projects during the semester
NO final examination

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

No

Notes/Handbook

To be provided