EPFL

ME-437 **Advanced solid mechanics**

Curtin William

| Cursus | Sem. | Type |
|---|---|---|
| Mechanical engineering | MA1, MA3 | Opt. |

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|---|---|
| Language of teaching | English |
| Credits | 5 |
| Session | Winter |
| Semester | Fall |
| Exam | Written |
| Workload | 150h |
| Weeks | 14 |
| **Hours** | **5 weekly** |
| Lecture | 3 weekly |
| Exercises | 2 weekly |
| **Number of positions** | |


## 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
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.
Laminate theory: the special case of fiber composites as layered anisotropic materials, connecting fiber/matrix properties to macroscopic structural response.
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.
Contact mechanics: basic analysis of bodies in contact and the generation of local stresses, and implications for friction and wear.
Other topics may be covered as interest and time permit.

## 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 may include:
Mini-projects to perform analyses
Project on topic of student interest

## Expected student activities

In-class participation
Collaborative problem solving
Execution of mini-projects

## Assessment methods

Graded mini-projects
Final written exam

## Supervision

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|---|---|
| Office hours | Yes |
| Assistants | Yes |
| Forum | Yes |

## Resources

### Virtual desktop infrastructure (VDI)

No

### Notes/Handbook

To be provided