Module Description, available in: EN

Advanced structural mechanics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvMech

Valid for academic year

2026-27

Last modification

2025-11-04

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

TSM Technical scientific module

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic engineering knowledge of structural mechanics, analysis and linear algebra as well as FE element simulation at Bachelor level of Mechanical Engineering studies.
A brief summary of relevant engineering mechanics concepts will be provided prior to the lecture as a self-study revision course.

Brief course description of module objectives and content

This course provides a comprehensible introduction to basic concepts of continuum mechanics, material modelling and failure assessment for metals and polymers.

The students learn the fundamentals of tensor algebra and gain comprehensible insight into the governing mechanical and thermo-mechanical concepts of continuum mechanics. On this basis, an overview is given of state of the art material models for metals and polymers to empower students to competently select advanced material models as implemented in modern Finite Element tools. Finally, the lecture provides a clear insight into the microstructural foundations of failure in metals as well as an overview of mechanical assessment methods as applied in engineering practice. The course is accompanied by regular exercises and hands-on workshops in which advanced material models and assessment methods are applied to practical problems.

Aims, content, methods

Learning objectives and competencies to be acquired

- **Basic tensor algebra and calculus**
  - Vector and tensor algebra
  - Tensor properties and decompositions
- **Continuum mechanics**
  - Kinematics (deformation measures)
  - Kinetics (stress measures)
  - Equilibrium equations
  - Balance laws
- **Material behaviour & models for metals**
  - Basic modelling principles
  - Elasticity and anisotropy
  - Plasticity
- **Material behaviour & models for polymers**
  - Hyperelasticity
  - Plasticity (influence of hydrostatic pressure)
  - Damage & fracture of adhesives

Module content with weighting of different components

- Students are familiar with basic tensor algebra to understand fundamental continuum mechanical concepts.

- Students are familiar with the building blocks of continuum mechanics such as kinematics and kinetics concepts as well as equilibrium equations and balance laws as governing equations of mechanical problems.

- Students have a broad understanding of the basic material behaviour of metals and polymers including elasticity, hyperelasticity, plasticity, visco-elasticity, visco-plasticity and creep / relaxation as well as isotropy, orthotropy and anisotropy.

- Students are able to appropriately select and deploy linear and non-linear material models in Finite Element simulations.

- Students know the basic failure mechanisms for metals and polymers; they are able to select appropriate mechanical assessment methods and perform basic assessments.

Teaching and learning methods

Frontal Teaching (ca. 60%), exercises and 2 workshops incl. Finite Element application (ca. 40%)

Literature

Script

Further literature (sorted by comprehensiveness and level of difficulty):

- Gross D. et al. (2018) Technische Mechanik 4 – Hydromechanik, Elemente der Höheren Mechanik, Numerische Methoden, 10. Auflage. Springer Vieweg. (https://doi.org/10.1007/978-3-662-55694-8)
- Altenbach H. (2018) Kontinuumsmechanik – Einführung in die materialunabhängigen und materialabhängigen Gleichungen, 4. Auflage. Springer Vieweg. (https://doi.org/10.1007/978-3-662-57504-8)
- Lemaitre J. & Chaboche J.-L. (2000) Mechanics of Solid Materials. Cambridge University Press. (https://doi.org/10.1017/CBO9781139167970)
- Bergström J (2015) Mechanics of Solid Polymers, Theory and Computational Modeling. William Andrew Publishing. (https://doi.org/10.1016/C2013-0-15493-1)
- Ottoson N. & Ristinmaa M. (2005) The Mechanics of Constitutive Modeling, 1st Edition. Elsevier Science. (https://doi.org/10.1016/B978-0-08-044606-6.X5000-0)

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

Open book