Module Description, available in: EN

Advanced structural mechanics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvMech

Valid for academic year

2020-21

Last modification

2019-08-31

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

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

Week	Subject
MW1	**Basic Tensor Algebra & Calculus 1** - Vector and tensor algebra
MW2	**Basic Tensor Algebra & Calculus 2** - Selected tensor properties and problems - Tensor calculus
MW3	**Continuum Mechanics 1** - Basic definitions - Kinematics of continuums
MW4	**Continuum Mechanics 2** - Kinetics of continuums
MW5	**Continuum Mechanics 3** - Equilibrium equations, equations of motion - Overview of balance laws
MW6	**Material Behaviour & Models for Metals 1** - Material behaviour overview - Basic modelling principles - Elasticity
MW7	**Material Behaviour & Models for Metals 2** - Plasticity - Visco-plasciticity, creep / relaxation
MW8	**Failure Mechanisms & Assessment Methods 1** - Failure mechanisms of metals - Static assessment methods for metals
MW9	**Failure Mechanisms & Assessment Methods 2** - Fatigue assessment methods for metals
MW10	**Workshop 1** Application of Material Models and Assessment Methods for Metals
MW11	**Material Behaviour & Models for Polymers 1** - Material behaviour overview - Plasticity (influence of hydrostatic pressure) - Hyperelasticity
MW12	**Material Behaviour & Models for Polymers 2** - Visco-elasticity, visco-plasticity, creep / relaxation - Cohesive zone models for bonded interfaces
MW13	**Material Behaviour & Models for Polymers 3** - Parameter identification and optimisation methods
MW14	**Workshop 2** Application of Material and Damage Models for Polymers

Contents of module with emphasis on teaching content

- 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

Certification requirements

Module uses certification requirements

Certification requirements for final examinations (conditions for attestation)

Active participation in two Workshops (MW10, MW14) with submission of two reports in teams of two

Basic principle for exams

As a rule, all the standard final exams for modules and also all resit exams are to be in written form

Standard final exam for a module and written resit exam

Kind of exam

written

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

Open book

Special case: Resit exam as oral exam

Kind of exam

oral

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

Open book