Valid from 2024.HS

Module description: Strength of Materials 1

Module Code	t.BA.MT.FL1.19HS
ECTS Credits	2
Language of Instruction/Examination	German
Organizational Unit	IMES
Module Coordinator	Ralf Pfrommer
Legal Framework	The module description is part of the legal basis in addition to the general academic regulations. It is binding. During the first week of the semester a written and communicated supplement can specify the module description in more detail.
Module Characteristic	Type 1a 2 lecture lessons per semester week and class
Module Description	Students are familiarised with the base quantities of the strength of materials and introduced to stress calculations for simple structures subjected to tension/compression/bending. Tensors are introduced as a basic mechanical quantity, taking the example of the stress tensor.

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Module Content	• 1. Base quantities of the strength of materials • 1.1 Function and classification of the strength of materials • 1.2 Characteristic values of the tensile test • 1.3 Base quantities of the strength of materials • 1.3.1 Normal and shear stress • 1.3.2 Change of length, strain and transversal contraction • 1.3.3 Change of angle, shear • 1.3.4 Young's and shear modulus, Poisson's ratio, thermal expansion coeff. • 1.4 Hooke's law • 2. Tension and compression of rods • 2.1 Normal stresses under variable cross sections • 2.2 Deformations of rod systems • 2.2.1 Statically determined systems • 2.2.2 Statically undetermined systems • 2.2.3 Condition of compatibility • 2.2.4 Examples • 3. Tensors in mechanics* • 3.1 States of spatial stress • 3.2 Stresses in the tetrahedral element • 3.2.1 Stress and normal vector • 3.2.2 Cauchy's formula • 3.3 Stress tensor • 3.2.1 Stress tensor as a linear map • 3.3.2 Tensor transformation under rotation of the coordinate system • 3.3.3 Principal directions and eigenvalues • 3.3.4 Stress tensor of the biaxial stress state • 3.3.5 Examples • 3.4 Strain tensor • 3.4.1 Biaxial strain state • 3.4.2 Evaluation of strain gauge measurements • 3.5 Mohr's circle • 3.5.1 Graphical visualization of the tensor transformation • 3.5.2 Special stress states • 4. Stresses caused by bending • 4.1 Introduction to calculation of bending stress • 4.1.1 Neutral plane, tension and compression zone • 4.2 Area moments of inertia • 4.2.1 Simple cross sections • 4.2.2 Parallel axis theorem • 4.2.3 Composite cross-sections, profile cross-sections • 4.2.4 Area inertia tensor • 4.2.4 Principal directions and moments • 4.3 Symmetrical and asymmetrical bending • 4.4 Examples • ()* This section is fundamental for all subsequent mechanics and physics classes.
Prerequisite Knowledge	This module requires mastery of the matters of the classes Analysis 1 and 2, Algebra and Statistics 1 and 2 as well as Statics.

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Learning Objectives (Competences)

Students...	Competencies	Taxonomies
Is able to calculate the normal stress in rods as well as the deformations of simple rod systems	F, M	K4
Knows the base quantities of the strength of materials and is able to list the definitions without any aids	M, F	K4
Is able to compute the stress tensor in a rotated system as well as its eigenvalues and principal directions	M, F	K4
Is able to transform a biaxial stress state graphically by means of Mohr's circle	M, F	K4
Is able to determine area moments of inertia of arbitrary cross sections and their principal moments and directions	M, F	K4
Is able to calculate stresses in arbitrary cross sections in the case of uniaxial bending	M, F	K4
Knows the definition of second order tensors and the difference of a second order tensor to a first order tensor (vector)	M, F	K4

Performance Assessment

End-of-module exam	Assessment	Length (min.)	Weighting	Form
written exam	Grade	90	80	acc. to module agreement

Performance assessment during the semester	Assessment	Length (min.)	Weighting	Form
written exam	Grade	45	20	acc. to module agreement

Classroom Attendance Requirement

None

Learning material

- Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 2, Elastostatik Springer-Verlag, 13. Auflage, 2017 (www.springer.com)

Comments

The lecturers in FL1 jointly create a end-of-semster exam that is the same for all classes. The lecturers create the midterm exams individually, but coordinate them with each other with respect to the level of difficulty.