TECHNISCHE HOCHSCHULE LÜBECK

Module: Selected Topics of the Finite Element Method

Level	Master	**Short Name**	STFEM
Responsible Lecturers	Schieck, Berthold, Prof. Dr.-Ing.		
Department, Facility	Mechanical Engineering and Business Administration		
Course of Studies	Mechanical Engineering, Master		
Compulsory/elective	Compulsory	**ECTS Credit Points**	5
Semester of Studies	1	**Semester Hours per Week**	4
Length (semesters)	1	**Workload (hours)**	150
Frequency	SuSe	**Presence Hours**	60
Teaching Language	English	**Self-Study Hours**	90

The following section is filled only if there is **exactly one** module-concluding exam.

Exam Type	Portfolio Exam	**Exam Language**	English
Exam Length (minutes)	120	**Exam Grading System**	One-third Grades
Learning Outcomes	The students understand the basics of the mechanics of solids, restricted to linear theory and Cartesian coordinates: vector and matrix calculus (including summation convention), differential calculus on vector fields, stress tensor, balance of linear and angular momentum, strain tensor, linear elastic isotropic material, elasticity tensor, the principles of virtual work and of minimum of total potential. They understand the derivations of the basic equations of the Finite Element Method (FEM) in pure displacement formulation (classic standard FEM) and understand, how standard finite elements can be established, including trial functions, continuity requirements, load vector, stiffness matrix and coincidence matrix by the examples of simple membrane triangle and quad elements, 3 dim tetrahedron and brick elements, and have same basic knowledge about plate and shell elements. They have first experience in applications, including h and p refinement, and typical problems like stress concentrations and singularities. Finally, they understand the basics of dynamics: d´Alembert´s principle, explicit and implicit time integration and the basic features of modal analysis and its application.		
Participation Prerequisites			

The previous section is filled only if there is **exactly one** module-concluding exam.

Consideration of Gender and Diversity Issues	✘ Use of gender-neutral language (THL standard) ✘ Target group specific adjustment of didactic methods ✘ Making subject diversity visible (female researchers, cultures etc.)

Applicability	The present module is closely related to the course on Computer Aided Techniques in Design (wind turbine project), which can be considered as a practical training in FEM, too.
Remarks	

TECHNISCHE HOCHSCHULE LÜBECK

Module Course: Selected Topics of the Finite Element Method

(of Module: Selected Topics of the Finite Element Method)

Course Type	Lecture	**Form of Learning**	Presence
Mandatory Attendance	no	**ECTS Credit Points**	5
Participation Limit		**Semester Hours per Week**	4
Group Size		**Workload (hours)**	150
Teaching Language	English	**Presence Hours**	60
Study Achievements ("Studienleistung", SL)		**Self-Study Hours**	90
SL Length (minutes)		**SL Grading System**	

The following section is filled only if there is a course-specific exam.

Exam Type		**Exam Language**	
Exam Length (minutes)		**Exam Grading System**	
Learning Outcomes			
Participation Prerequisites			

The previous section is filled only if there is a course-specific exam.

Contents

Basics of the mechanics of solids, restricted to linear theory and Cartesian coordinates:

- Vector and matrix calculus (including summation convention), differential calculus on vector fields
- Stress tensor, balance of linear and angular momentum
- Strain tensor
- Linear elastic isotropic material, elasticity tensor
- The principles of virtual work and of minimum of total potential

The basic equations of the Finite Element Method (FEM) in pure displacement formulation (classic standard FEM):

- Trial functions
- Continuity requirements
- Load vector
- Stiffness matrix
- Coincidence matrix

Examples:

- Simple membrane triangle and quad elements
- 3 dim tetrahedron and brick elements
- Basic knowledge about plate and shell elements
- h and p refinement
- Typical problems like stress concentrations and singularities

Dynamics:

- d´Alembert´s principle

	• Explicit and implicit time integration • Modal analysis and its application
Literature	**Bathe, Klaus-Jürgen:** Finite Element Procedures in Engineering Analysis. Prentice Hall Inc., Englewood Cliffs, NJ, USA, 1982, 2nd revised edition 1995, 2014. **Zienkiewicz, O. C., Taylor, R. L.:** The finite element method. 5th edition. Vol. 1: the basis; vol. 2: solid mechanics; vol. 3: fluid dynamics. Butterworth Heinemann, Oxford, Auckland, Boston, etc. 2000. **A. Bertram:** Elasticity and plasticity of large deformations. An introduction. Springer, Berlin, Heidelberg, 2005 **Basar, Y., Krätzig, W.B.:** Theory of Shell Structures, VDI Verlag 2000
Remarks	