

Module: Selected Topics of the Finite Element Method

Level	Master	Short Name	STFEM
Responsible Lecturers	Schieck, Berthold, Prof. DrIng.		
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
he following section is filled on	ly if there is exactly or	ne module-concluding exam.	1
Exam Type	Portfolio Exam	Exam Language	English
Exam Length (minutes)	120	Exam Grading System	One-third Grades
Learning Outcomes	(including summation stress tensor, balanc linear elastic isotropio	Cartesian coordinates: vector and convention), differential calculure of linear and angular momenture material, elasticity tensor, the p	d matrix calculus s on vector fields, ım, strain tensor,
Learning Outcomes	to linear theory and C (including summation stress tensor, balanc linear elastic isotropic work and of minimum They understand the Element Method (FE FEM) and understand including trial function matrix and coincident triangle and quad ele	Cartesian coordinates: vector and convention), differential calculure of linear and angular momenture material, elasticity tensor, the p	d matrix calculus s on vector fields, im, strain tensor, principles of virtual ans of the Finite tion (classic standar can be established, vector, stiffness aple membrane rick elements, and
Learning Outcomes	to linear theory and C (including summation stress tensor, balanc linear elastic isotropic work and of minimum They understand the Element Method (FE FEM) and understand including trial function matrix and coincident triangle and quad elemate same basic known They have first experienced.	Cartesian coordinates: vector and convention), differential calculure of linear and angular momenture material, elasticity tensor, the part of total potential. derivations of the basic equation M) in pure displacement formular d, how standard finite elements of the continuity requirements, load ce matrix by the examples of sime ments, 3 dim tetrahedron and brown conventions.	d matrix calculus s on vector fields, im, strain tensor, principles of virtual ans of the Finite tion (classic standar can be established, vector, stiffness aple membrane cick elements, and ements.
Learning Outcomes	to linear theory and C (including summation stress tensor, balanc linear elastic isotropic work and of minimum They understand the Element Method (FE FEM) and understand including trial function matrix and coincident triangle and quad elemate same basic known they have first experand typical problems Finally, they understand	Cartesian coordinates: vector and a convention), differential calculure of linear and angular momenture material, elasticity tensor, the proof total potential. derivations of the basic equation M) in pure displacement formulated, how standard finite elements on continuity requirements, load ce matrix by the examples of simplements, 3 dim tetrahedron and browledge about plate and shell elemente in applications, including helike stress concentrations and simplements of dynamics: d'Aleme integration and the basic feat	d matrix calculus s on vector fields, im, strain tensor, or
Participation Prerequisites	to linear theory and C (including summation stress tensor, balanc linear elastic isotropic work and of minimum They understand the Element Method (FE FEM) and understand including trial function matrix and coincident triangle and quad elehave same basic known They have first experand typical problems Finally, they understate explicit and implicit times.	Cartesian coordinates: vector and a convention), differential calculure of linear and angular momenture material, elasticity tensor, the proof total potential. derivations of the basic equation M) in pure displacement formulated, how standard finite elements on continuity requirements, load ce matrix by the examples of simplements, 3 dim tetrahedron and browledge about plate and shell elemente in applications, including helike stress concentrations and simplements of dynamics: d'Aleme integration and the basic feat	d matrix calculus s on vector fields, im, strain tensor, or
Participation Prerequisites	to linear theory and C (including summation stress tensor, balanc linear elastic isotropic work and of minimum They understand the Element Method (FE FEM) and understand including trial function matrix and coincidentriangle and quad elemate same basic known They have first experand typical problems Finally, they understate explicit and implicit til analysis and its applications.	Cartesian coordinates: vector and a convention), differential calculure of linear and angular momenture material, elasticity tensor, the part of total potential. derivations of the basic equation M) in pure displacement formulared, how standard finite elements of the construction of the examples of simple ments, 3 dim tetrahedron and browledge about plate and shell elemented in the properties of the construction of the basics of dynamics: d'Aleme integration and the basic feat cation.	d matrix calculus s on vector fields, im, strain tensor, or
Participation Prerequisites he previous section is filled onl Consideration of Gender	to linear theory and C (including summation stress tensor, balanc linear elastic isotropic work and of minimum They understand the Element Method (FE FEM) and understand including trial function matrix and coincidentriangle and quad elemate same basic known They have first experand typical problems Finally, they understate explicit and implicit till analysis and its applications of the control	Cartesian coordinates: vector and a convention), differential calculure of linear and angular momenture material, elasticity tensor, the part of total potential. derivations of the basic equation M) in pure displacement formulared, how standard finite elements of the construction of the examples of simple ments, 3 dim tetrahedron and browledge about plate and shell elemented in the properties of the construction of the basics of dynamics: d'Aleme integration and the basic feat cation.	d matrix calculus s on vector fields, im, strain tensor, or inciples of virtual as of the Finite tion (classic standar can be established, vector, stiffness aple membrane rick elements, and ements. In and p refinement, ingularities.
Participation Prerequisites the previous section is filled only	to linear theory and C (including summation stress tensor, balanc linear elastic isotropic work and of minimum They understand the Element Method (FE FEM) and understand including trial function matrix and coincident triangle and quad elehave same basic known They have first experand typical problems Finally, they understate explicit and implicit tile analysis and its application of the sex of gender-new triangle with the same basic known the sa	Cartesian coordinates: vector and a convention), differential calculure of linear and angular momenture material, elasticity tensor, the proof total potential. derivations of the basic equation M) in pure displacement formulated, how standard finite elements of the construction of the examples of simple ments, 3 dim tetrahedron and browledge about plate and shell elemented in the proof of the proof of the construction of the basics of dynamics: d'Aleme integration and the basic feat cation.	d matrix calculus is on vector fields, im, strain tensor, orinciples of virtual ins of the Finite ition (classic standards and be established, vector, stiffness in the membrane rick elements, and ements. In and p refinement, ingularities. In embert's principle, itures of modal

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	

2 01.07.2019



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 on	ly 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

3 01.07.2019

	Explicit and implicit time integrationModal 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	

4 01.07.2019