Studiengang: *Program:*	**Master of Science Maschinenbau** *Master of Science in Mechanical Engineering*			FACH HOCHSCHULE LÜBECK University of Applied Sciences
1 Modul: *Module:*	**Selected Topics in Finite Elements** *Ausgewählte Temen aus der Methode der finiten Elements*			**English** *Englisch*
	Semester *Semester*	**Dauer** *Duration*	**Status** *Status*	**Turnus** *Regular cycle*
	1. Semester	1 Semester	compulsory	annual
	Kreditpunkte *Credits*	**Aufwand** *Workload*	**Kontaktzeit** *Contact-hours*	**Selbststudium** *Student's efforts*
	5 ECTS	150hrs	4hrs/week = 60hrs Lecture	15hrs Preparation and post processing 75hrs Self-study

2 Beschreibung
Description

The Finite Element Method (FEM) is the most common numerical method for the analysis of problems in the wide field of continuum mechanics beyond the technical mechanics, which serves mainly only for topologically 1-dimensional problems. The continuum mechanics can be split into the mechanics of solids, which is considered in the present course, and fluid mechanics that won´t be considered here.

3 Lernziele
Learning Outcomes

- Introduction into the mathematical and mechanical fundamentals of FEM: stress and strain tensor, equilibrium condition, constitutive equation for isotropic elastic material, the principle of virtual work and the principle of the minimum of total ,potential; all this in the Euclidean space with Cartesian coordinates and components. Only linear theory will be considered.
- Brief description and presentation of the most common element types and assessment of their performance.
- Improvement methods for the discretization: h (mesh) and p(polynomial degree) refinement.
- Numerical examples with different types of volume elements; problems in the analysis of plates and shells.
- Some basics of nonlinear analysis, e.g. buckling of a column.
- Basics of dynamic analysis, explicit and implicit time integration

4 Schlüsselqualifikationen
Key qualifications

Sozialkompetenz *Social Competence*	Methodenkompetenz *Competence in Methods*	Selbstkompetenz / Personenkompetenz *Self-Competence Personal Competence*	Interkulturelle Kompetenz *Intercultural Competence*	Medienkompetenz *Media-Competence*
	X			

5 Lehrveranstaltung/ -methoden
Course type and methods

Lecture

- Seminar-like teaching
- Exercises and examples (case studies)

Self-study / homework

- Exercises for the consolidation of the learning matter

6 Vorbedingungen / Vorkenntnisse
Prerequisites

- Strongly recommended: Vector and matrix calculus, differential calculus for functions with variable sets, i.e. differential calculus on vector fields, divergence gradient and curl operator.
- Helpful: Gaussian divergence theorem,

7 Arbeitsmittel / Literatur
Required material / Literature

- Worksheets with exercises will be handed out in the lectures and will be placed on the download server.

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
- Flügge, W.: Statik und Dynamik der Schalen. Springer Verlag 1934 (1st edition, reprint 1981). English translation: Stresses in Shells, Springer Verlag 1960, 1973
- Basar, Y., Krätzig, W.B.: Theory of Shell Structures, VDI Verlag 2000

Detailinformationen

8 Inhalte

Course topics

Basics

- Vector and matrix calculus, differential calculus on vector fields
- Stress tensor and surface traction, equilibrium condition
- Displacement field, strains and rotations in the theory of small deformations (= linear theory)
- Linear elastic material law
- The principles of virtual work and of the minimum of total potential
- The fundamental equations of FEM
- Continuity requirements

Some basic types of finite elements

- Simple tetrahedron element
- General finite element formulation
- p and h refinement
- Flat membrane elements
- Plate and shell elements

Dynamics

- Basics
- Explicit and Implicit Time integration
- Modal Analysis

Large Deformations and Loss of Stability

9 Prüfungsform

Assessment

Portfolio exam: Compulsory participation in some presentations with directly subsequent brief tests (25%) and a final written examination (2 hours) at the end of the term (75%)

10 Voraussetzung für die Vergabe von Kreditpunkten

Requirements for granting of credits

- Successful passing of exam

11 Weiterführende Veranstaltungen

Related courses

- Computer Aided Techniques in Design (by Prof. Dr.-Ing. D. Warnack, compulsory)
- Mechanics of Solids (by Prof. Dr.-Ing. B. Schieck, elective)

12 Zuordnung

Classification

Mathematik & Naturwissenschaft *Mathematics & Natural Sciences*	Ingenieur-wissenschaften *Engineering Science*	Ingenieur-anwendungen *Engineering Application*	Entwicklung & Konstruktion *Design*	Werkstoffe *Material*	Wirtschaft, Management, Sprachen *General Education*	Anderes *Other*
X	X	X	X			

13 Modulbeauftragter / Lehrpersonen

Responsible person / Lecturers

Prof. Dr.-Ing. B. Schieck