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University of Applied Sciences

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Studienordnung für den Master-Studiengang
Computer Aided Mechanical Engineering (CAME)
an der Fachhochschule Bielefeld
(University of Applied Sciences)
vom 21.12.2005

Aufgrund des § 2 Abs. 4 und des § 86 Abs. 1 des Gesetzes über die Hochschulen des Landes Nordrhein-Westfalen (Hochschulgesetz - HG) vom 14. März 2000 (GV. NRW S. 190), zuletzt geändert durch Gesetz vom 30.11.2004 (GV. NRW S. 752), hat der Fachbereich Maschinenbau der Fachhochschule Bielefeld folgende Ordnung erlassen:

I n h a l t s ü b e r s i c h t

I. Allgemeines

§ 1 Aufgaben und Rechtsgrundlagen

(1) Die Studienordnung soll den Studierenden eine wirkungsvolle und zeitsparende Gestaltung des englischsprachigen Studiums nach dem vereinheitlichten europäischen Graduierungssystem ermöglichen. Sie regelt den inhaltlichen und organisatorischen Studienablauf, soweit dieser nicht in der Masterprüfungsordnung MPO festgelegt ist.

(2) Rechtsgrundlagen dieser Studienordnung in der jeweils gültigen Fassung sind:
1. das Gesetz über die Hochschulen des Landes Nordrhein-Westfalen (Hochschulgesetz - HG) vom 14. März 2000 (GV. NRW S. 190) und
2. die Prüfungsordnung für den Master-Studiengang Computer Aided Mechanical Engineering CAME an der Fachhochschule Bielefeld vom 18.03.2004.

II. Studienstruktur

§ 2 Studienbeginn

Aufgrund der Modularität des Studienangebots kann das Studium sowohl zum Wintersemester (1. Semester in Bielefeld) als auch, nach Maßgabe freier Studienplätze, zum Sommersemester (2. Studiensemester, Partnerhochschule) aufgenommen werden.

§ 3 Aufbau und Inhalt des Studiums

(1) Der Studiengang *Computer Aided Mechanical Engineering* mit dem zugehörigen Masterabschluss (MSc) wird an der FH Bielefeld in Zusammenarbeit mit einer vertraglichen Partnerhochschule angeboten. Beide Partner stimmen ihr Angebot aufeinander ab.

(2) Die Regelstudienzeit für das Masterstudium beträgt drei Semester. Es besteht aus zwei Studiensemestern und einer Masterarbeit (Thesis), deren Bearbeitungsdauer fünf Monate beträgt und in englischer Sprache zu verfassen ist. Die Masterarbeit kann wahlweise an der FH Bielefeld oder an der Partnerhochschule durchgeführt werden.

(3) Der Studienumfang beträgt insgesamt 82 Semesterwochenstunden.

(4) Das Lehrangebot umfasst die folgenden Pflichtmodule (V=Vorlesung, P=Praktikum, PA= Projektarbeit):

a) Im Wintersemester:

1. Computer Aided Engineering – Application and Programming (3V, 3P)
   oder alternativ:
   - 1a. Computer Aided Control System Design (2V, 1P)
   - 1b. Machinery Noise (2V, 1P)
2. Dynamics of Machines and Structures (3V, 3P)
3. Finite Element Method – Design Optimization (3V, 3P)
4. Computational Signal Processing **(**3V, 3P)
   oder alternativ:
   - 4a. Computational Signal Processing (mod) (2V, 1P)
   - 4b. Numerical Analysis using MATLAB (2V, 1P)
5. Projektarbeit/Projektarbeiten **(**6 P)

b) Im Sommersemester:

1. Finite Element Method - Dynamics and Field Problems (3V, 3P)
2. Computer Aided Engineering - Mathematical Aspects **(**3V, 3P)
3. Computational Fluid Dynamics (3V, 3P)
4. Data Management **(**3V, 3P)
5. Projektarbeit (6 P)

Das Lehrangebot wird zur Hälfte von der Partnerhochschule erbracht.

(5) Darüber hinaus wird im Wintersemester im Umfang von 2 SWS eine Sprachausbildung angeboten. Wahlmodule können nach Maßgabe der Dozentinnen oder der Dozenten angeboten werden.

(6) Der Studienplan ergibt sich aus Anlage 1; die Modulbeschreibungen sind in Anlage 2 enthalten. Die Anlagen sind Bestandteil der Studienordnung.

§ 4 Formen der Lehrveranstaltungen

(1) Vorlesungen (V): Zusammenhängende Darstellung eines Lehrstoffes, Vermittlung von Fakten und Methoden durch die Lehrenden.

(2) Praktikum (P): Erwerben und Vertiefen von Kenntnissen durch Bearbeitung praktischer oder experimenteller Aufgaben. Die Lehrenden leiten die Studierenden an und überwachen die Veranstaltung. Die Studierenden führen praktische Arbeiten und Versuche durch.

(3) Projektarbeit (PA): Ingenieurmäßiges Bearbeiten und Lösen von technischen Problemstellungen.

III. Schlussbestimmungen

§ 5 Inkrafttreten, Veröffentlichung

Diese Studienordnung wird im Verkündungsblatt der Fachhochschule Bielefeld – Amtliche Bekanntmachungen – veröffentlicht und tritt am Tage nach ihrer Veröffentlichung in Kraft.

Ausgefertigt aufgrund des Beschlusses des Fachbereichsrates des Fachbereiches Maschinenbau vom 06.07.2005.

Bielefeld, den 21.12.2005

gez. Rennen-Allhoff
Prof. Dr. B. Rennen-Allhoff
Rektorin

Anlage 1 zur Studienordnung Master-Studiengang

Computer Aided Mechanical Engineering CAME
Studienplan

Modulübersicht		Credits nach ECTS	SWS
Wintersemseter (WS)			
WS 1 Computer-Aided Engineering – Applicat. and Program. (CAE-AP)	(6)	6	6
oder WS 1a Computer Aided Control System Design (CACSD)	(3)		
WS 1b Machinery Noise (MN)	(3)		
WS 2 Dynamics of Machines and Stuctures (DMS)		6	6
WS 3 Finite Element Method – Design Optimization (FEM-DO)		6	6
WS 4 Computational Signal Processing (CSP)	(6)	6	6
oder WS 4a Computational Signal Processing(mod) (CSPm)	(3)		
WS 4b Numerical Analysis using MATLAB (NAM)	(3)		
WS 5 Projektarbeit/Projektarbeiten (PA)		6	6
		----------	--------
		30	**30**
Sommersemester (SS)			
SS 1 Advanced Computer Aided Design - Mathematical Aspects (ACAD)		6	6
SS 2 Finite Element Method – Dynamics and Field Problems (FEM-DF)		6	6
SS 3 Computational Fluid Dynamics (CFD)		6	6
SS 4 Data Management (DM)		6	6
SS 5 Projektarbeit/Projektarbeiten (PA)		6	6
-		---------	-------
		30	**30**
Weitere Veranstaltungen (Vorkurse, Zusatzkurse)			
11. Einführungskurs Fremdsprachen und Deutsch (Vorkurs)			
12. Fremdsprachen		---	**2**
3. Studiensemester (je nach Beginn WS oder SS)			
13. Thesis (Masterarbeit) einschließlich des Kolloquiums		**30**	30
		-------	--------
Gesamt		**90**	**92**

	Technische Module				**Fachübergreifende Module**	
Winter-Semester	Computer Aided Eng. Appl a. Prog. 6 Credits	Dynamics of Mach. and Structures 6 Credits	FEM - Design Optim. 6 Credits	Computat. Signal Proc. 6 Credits	Projekt-Arbeit/en 6 Credits	Fremd-sprachen --
	Computer Aided Control System Design 3 Credits			Computat. Signal Proc. (mod) 3 Credits		
	Machinery Noise 3 Credits			Numerical Analysis using MATLAB 3 Credits		
Sommer-Semester	Advanced Computer Aided Design – Mathem. Aspects 6 Credits	FEM – Dynam. and Field Problems 6 Credits	Computat. Fluid Dynamics 6 Credits	Data Management 6 Credits	Projekt-Arbeit/en 6 Credits	
3. Studien-emester	Thesis incl. Kolloquium 30 Credits					

Anlage 2 zur Studienordnung Master-Studiengang Computer-Aided Engineering – Fächerbeschreibung

Gesamtbemerkungen zur Durchführung der Übungen, der Projektarbeiten und der Thesis

Ein wesentlicher Aspekt bei der Durchführung des Master-Studiums ist die Stärkung, Vermittlung und der methodischer Einsatz von Zusatzqualifikationen, die insbesondere

- das methodisch-analytische Denken stärken, und gleichzeitig die Kreativität, Innovativität und Flexibilität fördern,
- die systematische Findung von Problemlösungen und deren Umsetzung durch zielgerichtete Arbeits- und Problemlösungstechniken fördert,
- rhetorische Fähigkeiten bei der Darstellung und Vermittlung des erarbeiteten Stoffes, sei es einzeln oder in (kleinen) Gruppen in kurzen Übungsvorträgen, insbesondere aber auch in Form der Projektarbeiten und der Abschlussarbeit (Master Thesis), wobei letztere als öffentlicher Vortrag zu halten ist. Die rhetorischen Fähigkeiten werden u.a. im Modul 12 (Fremdsprachen) methodisch und didaktisch geschult.
- die Bereitschaft und Fähigkeit in Gruppen zu arbeiten fördert, die dort auftretenden Konflikte zu lösen und durch interdisziplinäre Ansätze wesentlich zur Zeit- und Kostenersparnis beizutragen.
- Bereitschaft zur Übernahme von Verantwortung in Form von Projektleitungen zu üben.

Durch gezielte Auswahl von Übungsaufgaben werden alle diese Zusatzqualifikationen eingeübt und vertieft. Die Projektarbeiten sind in Form eines Vortrages mit medialer Unterstützung vor der gesamten Gruppe zu präsentieren und zu verteidigen.
Die Thesis ist in einem öffentlichen Vortrag von 30 min Dauer zu präsentieren und zu verteidigen.
Anm.: Das abschließende Kolloquium ist nicht öffentlich.

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Modul WS 1: Computer Aided Engineering - Application and Programming

Recent rapid progress in the development of information technology has brought about great changes in the application of computers in design: new working models have emerged, leading to a new understanding of product development. This is reflected in the digital description of processes. The two-dimensional design of the geometry has changed to three-dimensional modelling on grounds of the integrative demands. The geometric models are changing to virtual product models; with the aid of all these, the tasks of the process chains can be supported. The use of management systems is of ever-increasing importance for the designing of processes and the administrative tasks and memory functions. This virtuality has to be interpreted as a triad: it means a complete digital procedure, in the sense of virtual companies it expresses the distributed procedure by means of net-works and makes it clear that multimedia techniques and virtual reality are applied. We can surely safely say that in future all complex products will be anticipated in a virtual way. This lecture will summarise the necessary techniques and methods.

1. Introduction to Computer-Aided Engineering
2. Hardware components and configuration of CAE-systems
3. Software components of CAE-systems
4. CAD-models for CAE-systems
5. CAD Technology
    - Input procedure
    - Basic elements for geometric modelling
    - Operators
    - Tools for exact working
    - Layer technique and structure of product

- Macro technique and parametric design
- Taking over drawings created conventionally
- Taking over 3D-Models

6. Graphical Software-Systems
   - Mathematical basics
   - Data structures of graphical systems
   - Graphical interfaces
   - Graphical user surfaces
   - Creation of details
   - Visibility procedures
   - Realistic graphics
   - Illumination models
7. Interfaces (Integration of CAX-applications)
   - Possibilities of connecting CA-applications
   - Types of interface
   - IGES (Initial Graphics Exchange Specification)
   - VDAFS (VDA-Flächenschnittstelle)
   - SET (Standard d'Échange et de Transfer)
   - STEP (Standard for External Representation of Product Data)
8. Rapid Prototyping
   - The basic idea
   - Stereolithography (STL)
   - Solid Ground Curing (SGC)
   - Selective Laser Sintering (SLS)
   - Laminated Object Modelling (LOM)
   - Fused Deposition Modelling (FDM)
   - 3-D Printing

WS 1a: Computer-Aided Control System Design (CACSD)

The module CACSD focuses on the application of model based control engineering methods to mechanical systems. It imparts essential elements of linear control system design and discusses fundamental methods within both time and frequency domain terms. The formal design starts with the control system specification, continues with modelling and real-time simulation of closed-loop systems, and includes finally implementation and instrumentation aspects. Due to digital controller implementation linear state-space principles of control design such as state feedback and observer are preferred. Optimization techniques round off the state-space approach. Mechanical systems operate often in such a way that common linearization techniques may fail; therefore, basic nonlinear control design methods are considered.

Content:

1. **Introduction to Control Engineering**
   - Brief History
   - Examples of application
2. **Basic Structures of Controlled Systems**
   - Open loop structures
   - Closed-loop structures
   - The effect of feedback control
   - Stability
3. **System Dynamics**
   - Modelling and simulation of mechanical systems

- Linearization
- Linear state-space models
- Laplace and Fourier transforms
- Time and frequency response
- Formal stability criteria

4. **Feedback Control Fundamentals**
   - Simple control systems
   - The basic feedback loop
   - Feedback control specifications
   - Closed-loop simulation
   - Implementation and instrumentation
   - Limitations of feedback control
5. **Advanced control concepts**
   - State feedback
   - The observer principle
   - Pursuit tracking
   - Riccati state feedback control
   - Kalman filter based observers
   - Nonlinear feedback control
6. **Software tools**
   - Matlab/Simulink/Real-Time Workshop
   - Scilab
   - 20-sim
   - CarSim (optionally)

WS 1b: Machinery Noise

The course in Machinery Noise will be accompanied by practical and theoretical exercises. Computer aided means they are used both in lectures and exercises.

Contents: Basic Acoustics

The Physical Nature of Sound

- Sound Levels and Decibel Scales
- The Acoustic Wave Equation
- Sound Spectra
- Spectrum Analysis

Propagation of Sound

- Outdoor Sound
- Sound in Enclosed Spaces

The Origin of Machinery Noise

- The Vibroacoustic Model
- Structure-born Sound
- Sound Radiation by Panels an Pistons
- Air-borne Sound

The Principles of Noise Control

- Basic Noise Control Procedure
- Noise Control Techniques

Modul WS 2: Dynamics of Machines and Structures (DMS)

In order to meet the demand for increased performance and efficiency, modern designs focus mainly on achieving higher rates of revolution and lighter structures, leading in many cases to contra-productive vibrations in the main structure or components. This module deals with techniques for generating mathematical models describing the vibration parameters of an elastic structure. The results are useful in enhancing the dynamic behaviour of a structure, and combining them with measured normal modes parameters provides strategies for further optimisation.

1. **Representation of Signals, Excitation Functions and System Response**
   - Fourier Series
   - Fourier Transform
2. **Analysis of Single Degree of Freedom Systems (1DOF)**
   - equation of motion / linearisation / variational equation
   - free vibrations / eigenvalues
   - excited vibration / resonance
   - harmonically excited systems (1DOF)
   - periodically excited systems (1DOF)
   - arbitrary transient excited systems (1DOF)
3. **Analysis of Multi-Degree-of-Freedom Systems (nDOF)**
   - equation of motion / Lagrange's Equation
   - discretisation of continua
   - structural matrices (M, G, D, K)
4. **Modal analysis**
   - eigenvalue and eigenvector calculation
   - orthogonality and normalisation of eigenvectors
   - modal mass, stiffness and damping matrices
   - generalised co-ordinates
   - modal parameter in the frequency domain
   - frequency response analysis
5. **Torsional Vibration Analysis/ Rotordynamics**
   - mathematical modelling
   - torsional vibration of continuous systems
   - free vibration of discrete systems
   - forced response of discrete systems
   - simulation of torsional vibration at drivetrains
6. **Lateral Vibration of rotating Shafts / Rotordynamics**
   - mathematical modelling
   - lateral vibration of continuous systems
   - free vibration of discrete systems
   - forced response of discrete systems
   - balancing of rotors
   - influence of bearings and seals
   - gyroscopic effect on rotating shafts
7. **Some Aspects of Non-linear Vibration**
   - stability of motion
   - phase plane portrait / singular points / limit cycle
   - self-excited oscillations
   - non-linear characteristics / response curves
   - parameter - excited vibration
   - some remarks on chaotic vibration
8. **Practical exercises with the following software:**
   - **Mathcad; Matlab/Simulink:**

eigenvalues / eigenvectors calculation, simulation of dynamic systems
- **ITI-Sim3.1:** simulation of dynamic systems
- **Nastran:** FE – analysis

Modul WS 3: FEM – Design Optimisation

The students are to be given an insight into procedures for simulating an elastic-plastic deformation process and optimising geometries. Furthermore they will be introduced to the requirements of the safe- life and/or fail-safe criteria required in particular for simulating and testing space structures for the aeronautical, aircraft and automobile industries.
The course will focus on the fact that high-strength materials such as light constructions (made of composites or titanium alloy) are resistant to stress, but highly sensitive in respect of stress singularities. The students will also be shown how damage prevention requires additional simulation of crack growth to eliminate the risk of cracks, which can cause serious damage to a structure, and will learn to use a variety of softwares to simulate non-linear geometric, material and deformation behaviour. The student will then be able to apply supplementary post processors to accomplish simulation of instability and steady-state crack growth, including crack deflection, under the influence of shear stresses.

1. **Theory**
   - the behavior of nonlinear and anisotropic materials (such as carbon- or glass- fibre)
   - contact problems between different elastic-plastic bodies
   - growth laws of biological structures
   - shape optimization by the theorem of constant stresses
   - stress singularity at a crack tip
   - unstable and stable crack propagation
2. **Application examples**
   - deforming a hinge out of a straight beam
   - pressing a car axle out of flat sheet metal
   - simulation of an unstable and a stable crack growth in a CT-Specimen
   - comparison between a simulated and an experimental crack growth in a hydro-pulse machine
   - simulation of a crack deflection due to shear stress influence
   - critical crack extension in an EPS- stage propellant tank of the ARIANE 5
   - optimisation of a rotor blade of a steam turbine in respect to shape and eigenfrequency

1. **Solution strategies**
   - Idealization of mechanical structures
   - Idealization of different types of materials
   - Incremental linearisation of a non-linear deformation process
   - Incremental and iterative solution strategies
   - method of virtual displacement to calculate a stress intensity
   - simulation of an unstable and a steady-state crack extension process

Modul WS 4: Computational Signal Processing

Computational Signal Processing (CSP) is used extensively in many branches of CAE, e.g. for digital control systems, data acquisition and experimental testing. It forms the basis for design techniques that are used to examine and monitor complex engineering systems and is used extensively in a wide variety of applications.
This module covers a selection of subjects which focus on methods of processing digital signals obtained from a variety of sources. Students are familiarised with the operation, (filter) design and

application of various signal processing techniques and presented with design methodologies for medium-complexity digital systems. This is based on the modular design of both hardware and software functions and the use of hierarchy. The implementation of various software tools is also examined.

1. **Mathematical and computational background**
- complex mathematics
- the Fourier series
- software packages
- signals in time and frequency domains
- sampling
- ADC/DAC and filtering

2. **Linear systems (transfer functions, block diagrams)**
- impulse, response,convolution
- sampling theorem
- quantization steps, errors

3. **Fourier Transform**
- continuous Fourier Transform + properties
- filtering in the continuous domain
- Discrete Fourier Transform
- digital filtering

4. **DSP processors**
- how they work
- DSP processing
- applications and extras

5. **Digital logic**
- binary numbers, logical operations
- Boolean functions
- Karnaugh maps + block diagrams
- Combinational logic

6. **Microprocessors**
- registers, counters, RAM, microprocessor overview
- RISC v CISC
- Fabrication technology
- Microprocessor Interfacing
- Analog/digital and digital/analog conversion sampling rates and reconstruction

7. **Computational processing**
- I/O-ports, daisy chain, interrupt-controller
- interrupt service routines
- measurement of statistically and continuously incoming events
- programming
- compression, encoder/decoder
- encryption/decryption

WS 4a: Computational Signal Processing (mod)

This modul differs from WS 4 by tranferring the mathematical aspeccts in the modul WS 4b.

WS 4b: Numerical Analysis using MATLAB

Required background or experience: The student must be qualified by background for a Bachelor of Science or Engineering with a strong mathematical orientation in engineering

Learning Objektives

Upon successful completion of this course the student should:

- Be able to understand and implement numerical algorithms for solving problems in Mechanical Engineering.
- Understand how to use the the software (MATLAB) in computers to obtain numerical results for the various problems.
- **Content: Principles and Goals of Numerical Analysis**
- **Introduction to MATLAB**
- **Linear Algebra**
  Properties of matrices
  Fundamental matrix algebra
  Solution of a system of linear equations
  Introduction to eigenproblems
- **Nonlinear Algebraic Equations**
  Discussion of methods
  Iterative Newton's Method
- **Fourier Analysis**
  Fourier series solutions
  Fourier integral transforms
  FFT-Analysis
- **Numerical Solution of Ordinary Differential Equations**
  Reduction to a system of first order differential equation
  Initial value problem
  Taylor series
  Single-step and multi-step methods
  First and second order methods
  Runge-Kutta Formulas
- **Numerical Solution of Partial Differential Equations**
  Strong and weak formulations
  Weighted residual formulation
  Galerkin and Rayleigh-Ritz formulation
  Finite element methods
- Software tools

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Modul SS 1: Finite Element Methods - Dynamics and Field Problems

In many fields of engineering and quantitative science the Finite Element Method (FEM) is the method of choice when it comes to analysing field problems which are governed by partial differential equations with complicated boundary conditions. Originally developed to solve statics problems in mechanical and civil engineering, the FEM has greatly enhanced its scope and has become the basis for many software tools in numerical simulation and CAE. Today's efficiency in the development of technical products as well as their mere existence (see e.g. modern cars, airplanes, space vehicles, electronic devices, drilling rigs but also hair-dryers, beverage cans) depend critically on the extensive use of numerical simulation tools based on this method.

This FEM course is designed to give

- an insight into FEM-methods (mode-based and explicit) for time-dependent and field problems (dynamics, temperature, vibrations, acoustics ...)
- training in using a commercial up-to-date FEM-code (ABAQUS)
- an overview of the interface problems of FEM-software in an integrated CAE-environment.

The aim of the course is to educate a qualified user of professional FEM-software. After completing the course, he or she should be able to

- choose the appropriate method and software,
- use it effectively,
- build meaningful and appropriate models,
- analyse the results and estimate their reliability,
- write user-subroutines for special problems,
- handle several CAD-FEM-interfaces,
- give advice when it comes to choosing commercial codes for special applications.

The FEM-course comprises the following topics:

1. Introduction to the mathematics of FEM (FEM as Galerkin-Method for partial differential equations)
2. Dynamic stress analyses and vibrations (time-stepping, eigenfrequencies, mode-based dynamics, introduction to code-usage)
3. Acoustics
4. Steady-state and transient thermal problems (element-library, modelling and discretisation,)
5. Other field-problems
6. Interfaces
7. Miscellaneous

Lectures (2 h per week) will be complemented with hands-on training (4 h per week) on the commercial FEM-code ABAQUS.
The course is based mainly on the books of O.C. Zienkiewics.

Modul SS 2: Advanced Computer Aided Design – Mathematical Aspects

The ability to design defect-free products in the real world has become the most common focus of the entire industrial design process. The key factor is the use of digital prototypes to resolve issues early in the product development.

Different techniques such as history based modelling with associated geometric entities, features and direct modelling of larger assemblies of hybrid objects, combined with collaborated engineering, is the method for reaching higher levels of quality, productivity and innovation.

For the next generation of machinery, be it automotive or aerospace engineering, it is a must to understand the computer-aided design process and to find the best method for saving time and costs.

The course CAD – MA is designed to give:

- an introduction to the mathematical representation of various objects
- an understanding of hybrid models, containment curves, surfaces and solids
- an insight into the analysis of associated geometry and feature programming
- an overview of data exchange
- training in various techniques of modelling, focused on large assemblies and free forms

The course has been designed to produce graduates with the skills and knowledge required by industrial design processes. The focus is on advanced assemblies and free form modelling.

The students will develop their expertise and hands-on experience with individual projects and exercises, using state of the art laboratories.

Lectures will be complemented with hands-on training on commercial codes.

Modul SS 3: Computational Fluid Dynamics

Computational Fluid Dynamics (CFD) is one of the modern software tools which today contributes to the methods found in Computer Aided Engineering (CAE). It can either be used to design the detailed structure of fluid machinery, for example, or to model processes within flowing matter. As in many other field simulations using CFD, the region of flow concerned is subdivided into an arbitrary number of cells for which the conservation equations of mass, momentum and energy are solved.

CFD simulations are carried out according to the following steps:

- The working volume where the flow is to be modelled is usually designed with the aid of CAD-software according to fluid dynamic behaviour. This means the choice of proper boundary conditions and resolution of geometric details. This pre-processing finishes with the subdivision of the volume into cells with some experience of the expected flow pattern.
- In the next step the user sets up a model of the fluid flow. This is to decide whether the flow is laminar or turbulent, compressible or incompressible, Newtonian or non-Newtonian, and to construct the conservation equations accordingly. Before the user submits his/her model to the solver it may be wise to select special discretisation schemes for some differential terms of the conservation equations. This will help to enhance stability during solution.
- Solution is the step with the lowest work load for the user, but with the heaviest load for the computer. Due to the character of the conservation equations, an iterative solution procedure is necessary for the simultaneous calculation of often more than 100,000 variables.
- Once a stable and converged solution is obtained the post-processing consists mainly of graphical visualisation of flow. Other figures of interest are overall balances and forces exerted on certain surfaces.

Applying CFD today one usually employs commercial software, which offers a high degree of automation and comfort. This means most of the steps described above can be accomplished by a qualified user who puts everything together from the 'model menus' of the software.

The CFD course comprises the following:

1. Introduction to Computational Fluid Dynamics
2. Conservation of Mass, Momentum and Energy
3. Turbulence - Phenomenon and Modelling
4. Grid Design
5. Numerical Methods to Solve the Conservation Equations
6. Discretisation Schemes
7. Solving Strategies
8. Flow Modelling of heat and mass transfer

Lectures will be complemented by exercises with a commercial CFD code.

Modul SS 4: Data Management

Data management and data bases are used in modern engineering to store the data of the construction process. An engineer has to be able to use and to some extent to develop such data base applications.

The aim of this unit is to make the students capable of understanding the work of data base applications and to give an understanding of how to construct such applications.

1. Introduction to data storage (physical storage, file systems)
2. Database management systems (properties, server, hosts, networks)
3. Data modelling methods, ER-Modelling, relational data model, object-oriented data modelling.
4. Relational data bases (products, ER-Modell -> tables, SQL)

5. OO-data bases (products, extension of SQL)
6. Graphical user interfaces to database applications.

As an excercise a smaller application will be constructed by the students including ER-modelling, creation of tables, generation of data, queries.
Lectures will be complemented with hands-on training.

Erste Ordnung
zur Änderung der Masterprüfungsordnung
für den Studiengang Computer Aided Mechanical Engineering
an der Fachhochschule Bielefeld
vom 21.12.2005

Aufgrund des § 2 Abs. 4 und des § 94 Abs. 1 i. V. m. § 25 Abs. 4 und § 28 Abs. 1 des Gesetzes über die Hochschulen des Landes Nordrhein-Westfalen (Hochschulgesetz - HG) vom 14. März 2000 (GV. NRW. 2000 S. 190), zuletzt geändert durch Gesetz vom 30.11.2004 (GV. NRW S. 752), hat der Fachbereichsrat Maschinenbau der Fachhochschule Bielefeld folgende Ordnung als Änderungssatzung erlassen:

Artikel I

Die Masterprüfungsordnung für den Studiengang Computer Aided Mechanical Engineering an der Fachhochschule Bielefeld vom 18. März 2004 (Verkündungsblatt der Fachhochschule Bielefeld -Amtliche Bekanntmachungen- 2004, Nummer 13, Seite 41-55) wird wie folgt geändert:

In dem § 14 wird in Abs. 2 MPO eingefügt: „Die Modulprüfungen sind unmittelbar im Anschluss an die Vorlesungen zu absolvieren. Eine mit „nicht ausreichend“ bewertete Modulprüfung muss bei dem nächst möglichen Termin wiederholt werden.“

In § 17 Abs. 1 MPO werden die beiden Module WS 1 und WS 4 wie folgt aufgeteilt:

Modul	Vollmodul	Credits	Modul	Teilmodul	Credits
WS 1	Computer Aided Engineering – Application and Programming	6	WS 1a	Computer Aided Control System Design	3
			WS 1b	Machinery Noise	3
WS 2	Dynamic of Machines and Structures	6			
WS 3	Finite Element Method – Design Optimization	6			
WS 4	Computational Signal Processing	6	WS 4a	Computational Signal Processing (mod)	3
			WS 4b	Numerical Analysis using MATLAB	3
WS 5	Projektarbeit/ Projektarbeiten WS	6			
SS 1	Finite Element Methods – Dynamics and Field Problems	6			
SS 2	Computer Aided Engineering – Mathematical Aspects	6			
SS 3	Computaional Fluid Dynamics	6			
SS 4	Data Management	6			
SS 5	Projektarbeit/ Projektrarbeiten SS	6			

Artikel II

Diese Ordnung wird im Verkündungsblatt der Fachhochschule Bielefeld – Amtliche Bekanntmachungen – bekannt gegeben. Sie tritt einen Tag nach ihrer Veröffentlichung in Kraft.

Ausgefertigt aufgrund eines Beschlusses des Fachbereichsrates des Fachbereichs Maschinenbau vom 06.07.2005.

Bielefeld, den 21.12.2005

Die Rektorin
der Fachhochschule Bielefeld

gez. Rennen-Allhoff
Prof. Dr. B. Rennen-Allhoff