technische universität dortmund

Fakultät Maschinenbau

Module description Master of Science in Manufacturing Technology (MMT)

Module description

November 2023

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List of abbreviations

CP	Credit Points
E	Exercise
h	Hora/hour
L	Lecture
MMT	Manufacturing Technology
P	Project
SS	Summer Semester
SWS	Semester hours per week
WS	Winter Semester

Study plan

	1. Semester	2. Semester	3. Semester	4. Semester
Compulsory Modules	Module 10: Machining Technology I 5 CP	Module 13: Machining Technology II 5 CP	Module 3: Laboratory Work 6 CP	Module 1: Master's Thesis 30 CP
	Module 11: Plastics Technology 5 CP	Module14: Materials Technology 5 CP	Module 4: Scientific Project Work 9 CP	
	Module 12: Bulk Metal Forming 5 CP	Module 15: Sheet Metal Forming 5 CP		
	Module 2: Interdisciplinary Qualification 5 CP	Module 2: Interdisciplinary Qualification 5 CP		
Elective Modules	Elective Catalog 10 CP	Elective Catalog 10 CP	Elective Catalog 15 CP	
CP per Semester	30	30	30	30

Elective Catalog

Listed below are the elective modules, from which students have to choose to gain a total of 35 CP. Please mind that the range of elective modules may change.

Topics in Manufacturing Technology	MMT-20
Fundamentals of Robotics	MMT-21
Automation and Handling Systems	MMT-22
Finite Element Method I	MMT-23
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Advanced Simulation Techniques in Metal Forming I	MMT-25
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Introduction to Reliability Engineering	MMT-27
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Additive Manufacturing	MMT-29
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Parameter Identification	MMT-34
Finite Inelasticity	MMT-35
Nonlinear Continuum Mechanics	MMT-36
Nonlinear Finite Element Methods	MMT-37
Quality Management	MMT-38

MMT-1: Master´s thesis

Master-Program Manufacturing Technology
Section of Study: 4th semester

Duration: 1 semester	**CP:** 30	**Workload:** 900 h	
		Attendance time: 135 h	**Self study:** 765 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Master´s thesis, written elaboration		English	WS+SS	24	10
2	Master´s thesis, presentation		English	WS+SS	6	2

2 Content

The Master´s thesis is a scientific work that concludes the master program. It aims to demonstrate that the candidate is able to solve a problem independently within a period of 24 weeks by applying scientific methods. The topic of the master thesis should be chosen close to industry and must include the subject area of manufacturing technology. The Master's thesis can be issued and supervised by any university lecturer and any post-doctoral lecturer in the subject who is active in research and teaching and belongs to the Faculty of Mechanical Engineering at TU Dortmund University, the Faculty of Mechanical Engineering at the Ruhr-Universität Bochum or the Mechanical Engineering Teaching Unit of the Faculty of Engineering at the University of Duisburg-Essen. If the Master's thesis is to be carried out in another institution of the university or in an institution outside the university, this requires the approval of the chairperson of the examination committee.

3 Competence

By completing the Master´s thesis, students demonstrate their ability to perform a scientific work independently, to apply scientific knowledge, to solve engineering problems, and to perform a final oral presentation. Not only technical but also method competence shall be acquired. By preparing and performing the oral presentation, students also develop key skills in decision making, taking responsibility and having self-confidence.

4 Examination

Master´s thesis, written elaboration (80%) and presentation (20%). The master thesis should not exceed 100 pages. The master's thesis must always be written independently as an individual work. However, this does not preclude the topic of the master's thesis being worked on within a working group. In this case, it must be ensured that the contribution of the individual to be evaluated as an examination performance is clearly distinguishable and assessable according to objective criteria and fulfills the requirements according to paragraph 19 (1) of the Examination Regulation. The number of pages specified in the module handbook must adequately exceed the requirements of an individual thesis.

☐ Module examination	☒ Partial performance

5 Prerequisites

In order to start the Master's thesis, the students must have at least 70 CP.

6 Module Type and Usability of the Module

Compulsory module

7

Representative of the Module	**Responsible Faculty**
Dean	Faculty of Mechanical Engineering (7)

MMT-2: Interdisciplinary Qualification (MMT)

Master-Program Manufacturing Technology
Section of Study: 1st / 2nd semester

Duration: 2 semesters	**CP:** 10	**Workload:** 300 h	
		Attendance time: 90	**Self study:** 210

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Interdisciplinary Qualification (MMT)		English, other languages are offered	WS+SS	10	8

2 Content

The module „Interdisciplinary Qualification (non-technical elective course) can be offered by any academic unit of TU Dortmund University and must meet the following requirements:

- The content must be non-technical. Courses from the Faculty of Economics cannot be taken.
- The module is completed with 10 CP and may be composed of one single course or severals courses of different departments. The module is therefore completed either with partial performances or a module exam.

3 Competence

Completing elective modules from other disciplines allow students to be introduced to and become familiar with methods applied in other disciplines of science. In this way, students improve their language, social, and intercultural as well as diversity skills.

4 Examination

Written exam, presentation, assignment, seminar, or oral exam. The type of the exams will be announced at the beginning of the elected element. The module may be completed with a single course worth 10 CP or a combination of several single courses each worth less than 10 CP. The grade of the module is calculated by using the credit point weighted average of the single courses. Even though the total CP of the single courses may be higher than 10, the module will only be counted as 10 CP.

☒ Module examination	☒ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Compulsory module

7 Representative of the Module	**Responsible Faculty**
Dean	Faculty of Mechanical Engineering (7)

MMT-3: Laboratory Work (MMT)

Master-Program Manufacturing Technology **Section of Study:** 3rd semester							
Duration: 1 semester		**CP:** 6	**Workload:** 180 h				
			Attendance time: 45 h		**Self study:** 135 h		
1	**Module structure**						
	No.	**Element/Course**	**Type**	**Language**	**Cycle**	**CP**	**SWS**
	1	Laboratory Work I (MMT)	P(2)	English	WS+SS	3	2
	2	Laboratory Work II (MMT)	P(2)	English	WS+SS	3	2
2	**Content** The laboratory work specifically involves experimental research work. The specific objectives are defined by the chairs where the laboratory work is performed. The laboratory work is done in groups. Before the actual laboratory work, the experiments need to be prepared. This means that students have to make sure they have an adequate knowledge of the theoretical foundations and practical implementation of the experiment. Students can choose freely the chair or chairs and discipline for their laboratory work, depending on availability. The experimental contents are provided by the individual chairs.							
3	**Competence** After successful completion of the course, students are able to discuss different perspectives on an engineering problem and explain their own views. Students are able to deal with the different opinion approaches of other group members during a group work phase and to give and take constructive feedback. Furthermore, students understand the methodological approaches and procedures in the context of scientific work in mechanical engineering and are able to apply them to different problems.							
4	**Examination** Written or oral exam, written report, presentation and discussion. The type of the exams is announced at the beginning of the respective element. The module may be completed with a single course worth 6 CP or a combination of two courses each worth 3 CP. The grade of the module is calculated by using the credit point weighted average of the single courses. Even though the total CP of the single courses may be higher than 6, the module will only be counted as 6 CP. ☒ Module examination ☒ Partial performance							
5	**Prerequisites** None							
6	**Module Type and Usability of the Module** Compulsory module							
7	**Representative of the Module** Dean				**Responsible Faculty** Faculty of Mechanical Engineering (7)			

MMT-4: Scientific Project Work (MMT)

Master-Program Manufacturing Technology
Section of Study: 3rd semester

Duration: 1 Semester	**Credits:** 9,0	**Workload:** 270 h	
		Attendance time: 45	**Self study:** 225

1 Module structure

No.	Element/Course	Type	Language	Cycle	Credits	SWS
1	Scientific Project Work (MMT)	P(4)	English	WS+SS	9,0	4

2 Content

The Scientific Project involves a study-accompanying homework in the scope of 9 CP in a team work format. Each team member has to prepare an independent part proving their individual performance for evaluation by the examiner. Within four weeks after the submission of the homework, each student has to show the results by giving a presentation. Scientific Project Works are offered by the Faculty.

3 Competence

By preparing a scientific project work and doing an oral presentation, students acquire the competence to do scientific work and to apply scientific knowledge as well as gain technical and method competence. Furthermore, by working in intercultural teams, students acquire teamwork skills, presentation competence, etc., which promote the social and intercultural skills, i.e. professional key skills.

4 Examination

Written elaboration and oral presentation: Each candidate has to prepare his/her own elaboration of the topic in question, which shows the candidate's own achievements. After the submission of the paper, a presentation of the results will take place within four weeks in the form of a lecture by each candidate, whereby the oral presentation also skills such as presentation skills, rhetoric and expressiveness will be taken into account. The oral presentation will be evaluated with 20% of the overall performance. The duration of the project should not exceed 6 months and starts with the issue of the topic. If the duration of the work exceeds 6 months, the candidate has no right to further professional supervision and submission of the project work. In this case, the project work can be repeated as a whole (without recognition of a failed attempt) with a new topic.

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Compulsory module

7 Representative of the Module	**Responsible Faculty**
Dean	Faculty of Mechanical Engineering (7)

MMT-10: Machining Technology I

Master-Program Manufacturing Technology **Section of Study:** 1st semester							
Duration: 1 semester		**CP:** 5	**Workload:** 150 h				
			Attendance time: 40 h		**Self study:** 110 h		
1	**Module structure**						
	No.	**Element/Course**	**Type**	**Language**	**Cycle**	**CP**	**SWS**
	1	Machining Technology I	L(2.5)+ E(1.5)	English	WS	5	4
2	**Content** The module "Machining Technology I" imparts knowledge about the fundamentals of machining concerning the chip removal, energy transformation and mechanical loads. Furthermore, individual machining processes are covered, distinguished according to the categories of cutting processes and abrasive processes. Lastly, the topics of lubrication and cooling, tool coating and tool wear are discussed.						
3	**Competence** After successful participation in this module, students will be able to describe the basic processes involved in machining and explain the process from a mechanical and energetic point of view. The students will be able to explain the tool wear, cutting materials and cooling lubricant concepts for solving problems concerning specific cutting tasks in the area of both geometrically undefined and geometrically defined cutting edges. Furthermore, the students are able to analyze and compare methods for process evaluations and select them in the context practical issues.						
4	**Examination** Written exam ☒ Module examination ☐ Partial performance						
5	**Prerequisites** None						
6	**Module Type and Usability of the Module** Compulsory module						
7	**Representative of the Module** Biermann			**Responsible Faculty** Faculty of Mechanical Engineering (7)			

MMT-11: Plastics Technology

Master-Program Manufacturing Technology
Section of Study: 1st semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self-study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Plastics Technology	L(2)+E(2)	English	WS	5	4

2 Content

The module "Plastics Technology" intends to gain a deeper knowledge in the field of polymer materials and plastics processing. It provides students with a detailed knowledge about different polymer materials, their molecular structure and processing. The specific characteristic properties of polymer materials, e.g. thermal properties, are discussed and related to processing and applications. Rheological properties with respect to the different measurement setups and modeling methods are an important part to understand the material behavior while processing. With this fundamental knowledge, processing techniques like injection molding, extrusion and additive manufacturing are discussed. Students learn technological aspects as well as rules to design parts made of polymer materials. Within this context, the important connection of application-oriented and processing-oriented part design is part of the course.

3 Competence

This course introduces students to the field of polymers, including their typical characteristics and field of applications. They gain a profound understanding about different types of polymer materials, with a special focus on their application-oriented potential. Besides, they understand how processing and applications are interrelated. This course will enhance the ability of students to evaluate construction materials by using different interdisciplinary methods in order to choose a material for a specific field of application in a systematic way.

4 Examination

Written exam

☒ Module examination	☐ Partial performance

5 Prerequisites
None

6 Module Type and Usability of the Module
Compulsory module

7 Representative of the Module	**Responsible Faculty**
Handge	Faculty of Mechanical Engineering (7)

MMT-12: Bulk Metal Forming

Master-Program Manufacturing Technology
Section of Study: 1st semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self-study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Bulk Metal Forming	L(2)+E(2)	English	WS	5	4

2 Content

This module provides an advanced knowledge of the fundamentals of bulk metal forming technology, the corresponding forming machines, and processes. In addition, theoretical fundamentals with special emphasis on analytical methods are discussed. The lecture is divided into two parts. The first part gives the basics for bulk metal forming. After providing the fundamentals of materials technology with the mechanisms relevant to forming technology, the theory of plasticity is discussed in detail to understand the physics of the processes. It is shown how material properties can be determined with the help of different characterization methods and different analytical methods are introduced to solve forming problems. In the second part processes such as rolling, forging, cold forging, bar extrusion, and shear forming are introduced. The processes are considered both, analytically and technologically. Advantages and applications are presented, and typical defects and limitations are discussed. Further knowledge concerning forming machines is given discussing different press types.

Selected processes and their corresponding theories will also be presented in a live demonstration on current research setups in the laboratory to combine theory with practice.

As an important motivation for the further development of forming technology, possibilities of resource efficient manufacturing are explained. In exercises, the fundamental theories provided in the lectures are further explained, applied, and the application of analytical models of bulk metal forming processes are practiced. An optional voluntary midterm exam places students in an exam atmosphere, providing an opportunity to engage with exam-level assignments. With optional voluntary quizzes during the semester, the individual learning level will also be tested.

3 Competence

With the participation of this module, the students have a broad understanding of bulk metal processes and can differentiate between different process types, highlight their characteristics and choose the best process for a given manufacturing task. They possess a broad understanding of components, machinery, tools, measurement and control systems, and automation techniques. Further, students can model the processes analytically and understand the limitations of the modelling.

During the exercises, students perform analytical calculations individually. They are able to choose the proper modelling technique, construct the equivalent model and solve for desired quantities, such as forming forces. After participating in the lab visits, students are able to offer in-depth explanations on how the machines of the individual processes work, understand the difficulties of the machines and transfer the working principles to other machines.

4 Examination

There is a mandatory test in the form of a written exam work. The test lasts 90 minutes. In exceptional cases, the institute reserves the right to offer an oral exam.

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Compulsory module

7 Representative of the Module	**Responsible Faculty**
Korkolis	Faculty of Mechanical Engineering (7)

MMT-13: Machining Technology II

Master-Program Manufacturing Technology
Section of Study: 2nd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Machining Technology II	L(2.5)+ E(1.5)	English	SS	5	4

2 Content

Within the "Machining Technology II" lecture, different designs and essential components of cutting machine tools are covered in the course. This is followed by important operating equipment and fixtures with their functions and interfaces. The modular principle for fixtures and hydraulic fixtures are explained. This is followed by the treatment of tools followed by special design features for machine tools for high-speed and dry machining. In addition, peripheral systems for simulation as well as for the digitalization of cutting processes in the context of Industry 4.0 are presented.
The exercise covers the basic procedure for selecting a machine tool. The students work in groups on a practical problem from the field of machining. The topic includes the virtual procurement of a machine tool for a component to be machined.

3 Competence

Students will be able to explain the basic functions and essential components of machine tools and the associated devices and tools. They will be able to distinguish between different types of cutting machine tools. The students are able to categorize types and machine concepts and to select suitable ones for given, also special cutting processes.
After successful completion of the exercise, the students have a basic knowledge of planning and designing a cutting process and selecting a machine tool suitable for the process. They are able to draw up a work plan with the appropriate cutting tools for a component to be machined and to calculate the relevant parameters for machine selection. Furthermore, the students are able to evaluate the machine tool with the help of technical and economic criteria and to work out an optimal concept for a given cutting process. The students are able to acquire knowledge independently, to work on technical tasks in a team and to communicate results in the form of presentations.

4 Examination

Written exam

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Compulsory module

7 Representative of the Module	**Responsible Faculty**
Biermann	Faculty of Mechanical Engineering (7)

MMT-14: Materials Technology

Master-Program Manufacturing Technology
Section of Study: 2^{nd} Semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Materials Technology	L(2)+E(2)	English	SS	5	4

2 Content

The aim of this module is to provide a broad overview of common construction materials as well as advanced materials and their specific characteristics, their typical fields of application as well as their production processes and post-treatment. Furthermore, the students will analyze the microstructure of the different materials and learn about their effect on the materials properties as well as how post-treatments can adjust the properties of the materials for a certain application.

3 Competence

After successful participation, students are able to name the different material classes and give the basic definitions as well as name representative specific materials for each class. Furthermore, students will be able to describe the specific material properties of each material class and derive limits of each class for their industrial application. Finally, students are able to analyze and derive the materials requirements for a mutual application and choose appropriate materials as well as the suitable post-treatments.

4 Examination

The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

It is highly recommended to take the elective course "Basics of Materials and Technology" before.

6 Module Type and Usability of the Module

Compulsory module

7

Representative of the Module	**Responsible Faculty**
Tillmann	Faculty of Mechanical Engineering (7)

MMT-15: Sheet Metal Forming

Master-Program Manufacturing Technology
Section of Study: 2nd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Sheet Metal Forming	L(2)+E(2)	English	SS	5	4

2 Content

This module provides advanced knowledge of the fundamentals of sheet metal forming technology and the corresponding forming machines and processes. In addition, theoretical fundamentals with special emphasis on analytical methods are discussed.

After providing the fundamentals of sheet metal forming and discussing the membrane theory, conventional applications such as sheet and profile bending, deep drawing and roll forming as well as incremental forming, cutting and joining by forming, hydroforming, and impulse forming are discussed in detail. Selected processes and their corresponding theories will also be presented in a live demonstration on current research setups in the laboratory to combine theory with practice.

In additionally offered exercises, the fundamental theories provided in the lectures are further explained, applied, and the application of analytical models of sheet metal forming processes are practiced. An optional voluntary midterm exam places students in an exam atmosphere, providing an opportunity to engage with exam-level assignments. With optional voluntary quizzes during the semester, the individual learning level will also be tested.

3 Competence

With the successful participation of this module, students have a broad understanding of different sheet metal forming processes and are able to differentiate and highlight the characteristics. They possess a broad understanding of components, machinery, tools, measurement and control systems, and automation techniques. Further, the students will be able to model the process analytically and understand the limitations of modeling to identify specific problems and provide solutions for sheet metal forming tasks.

Based on analytical calculations performed in the exercises, students are able to choose the proper modelling technique, construct the equivalent model and solve for desired quantities, such as forming forces. After participating in the laboratory visits, students are able to offer in-depth explanations on how the machines of the individual processes work, understand the difficulties of the machines and transfer the working principles to other machines.

The lecture, exercise and laboratory visits extend students' analytical thinking.

4 Examination

There is a mandatory test in the form of a written exam work. The test lasts 90 minutes. In exceptional cases, the institute reserves the right to offer an oral exam.

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Compulsory module

7 Representative of the Module

Korkolis

Responsible Faculty

Faculty of Mechanical Engineering (7)

MMT-20: Topics in Manufacturing Technology

Master-Program Manufacturing Technology
Section of Study: 1st/2nd or 3rd semester

Duration: 1 semester	**CP:** 5 or 10	**Workload:** 150 h or 300 h	
		Attendance time:	**Self study:**

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Topics in Manufacturing Technology		English or German	SS+WS	5 or 10	4 or 8

2 Content

In the module „Topics in Manufacturing Technology" any course offered by any department/university can be taken if the following requirements are fulfilled:

- The content must be manufacturing technology.
- Prior written approval of suitability of a course by the MMT Coordination is required for crediting.
- The module can be composed of different courses of different universities/departments.
- The module can only be completed with 5 CP or 10 CP.

3 Competence

Students acquire in-depth and advanced knowledge in one or several further fields of manufacturing technology according to their individual preferences.

4 Examination

Written exam, presentation, assignment, seminar, or oral exam. The type of exam is usually announced at the beginning of the elected element. The grade of the module is calculated by using the credit-point weighted average of the single courses. So, even though the total of the CP of the single courses may amount to more than 5 or 10, the module will only be credited with 5 CP or 10 CP, respectively.

☒ Module examination	☒ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Dean	Faculty of Mechanical Engineering (7)

MMT-21: Fundamentals of Robotics

Master-Program Manufacturing Technology
Section of Study: 1st semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Fundamentals of Robotics	L(3)+E(1)	English	WS	5	4

2 Content

Facing shortage of skilled workers and relocation of production to high-wage industrial countries, the demand for automation with industrial robots is growing continuously. Knowledge of the various kinematic robot types, their advantages and disadvantages, the specific motion behavior of industrial robots and its mathematical description, the components of automation systems and, of course, aspects of safety are crucial for the proper design of robot systems. This course imparts the basic knowledge required to professionally configure robot cells for given tasks or to be able to assess their design. It covers the basics of automation and industrial robotics and starts with different kinematic robot types, their properties, and applications. It focuses robot kinematics including computation of rotations, usage of Denavit-Hartenberg-conventions to describe kinematic chains and the mathematical description of robot motions as used for robot simulation and control. It also provides basics of motion control and path planning, the systematic design of general handling systems, robot programming including teach-in, interactive and automatic offline-programming as well as robot hardware, accuracies of robot-based motions, aspects of safe robot-cell-design and safety equipment. These topics are discussed in lectures and trained in tutorials.

Topics:

- Which different kinematic types of industrial robots do exist and what are their characteristics?
- How can the position and path of a robot be calculated?
- How can robot motions be programmed and controlled (basics)?
- How can robot programming be improved by Simulation + Offline-Programming?
- Which hardware components are needed for composing a suitable robot-based automation system for a given task? (Kinematic robot types, drive components, internal and external sensors, grippers and effectors for various tasks, safety equipment)

3 Competence

After a successful completion of the module, students are able to describe and discuss the basics of industrial robotics. They are able to solve mathematical problems related to robot motions and controllers. They are able to compare and evaluate different solutions for robot applications.

4 Examination

The examination is a written exam (duration: 60 minutes) or an oral examination (duration: 30-45 minutes).

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Bickendorf	Faculty of Mechanical Engineering (7)

MMT-22: Automation and Handling Systems

Master-Program Manufacturing Technology
Section of Study: 2nd semester

Duration: semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Automation and Handling Systems	L(3)+E(1)	English	SS	5	4

2 Content

Industrial robots are a valuable tool for mastering current challenges in the manufacturing industry. They enable cost-effective and more sustainable production of increasingly individualized products in high-wage countries and help to overcome the shortage of skilled workers. To be able to do this, robot-based automation systems must be very well adapted to the task at hand. The aim of this course is to systematically look at the requirements of different production processes and translate them into high-performance solutions. Industrial robots are the core component of numerous automation systems for production and handling processes. This course covers production processes like primary shaping, forming, cutting, joining and assembly and examines their requirements on robot design, robot controllers, robot off-line programming, suitable effectors, and automation compatible workpiece design. As simulation based offline-programming is a prerequisite for the effective automation of a growing number of such production processes, simulation systems and offline-programming applications play an important part in this course. Sensor- and vision systems are also covered as essential components of many automation solutions, as well as programmable logic controllers.

Topics:

- Robot based production processes
- Sensors and measuring strategies to compensate inaccuracies of workpieces and automation components
- Automation compatible design
- Robot effectors, gripper selection, dimensioning of vacuum grippers
- Robot controllers, PLC
- Application specific offline-programming and simulation systems

3 Competence

After a successful completion of the module, students have acquired knowledge about how to design, program, use and operate a robot-based production cell or line as well as automated manufacturing facilities in general. This knowledge enables the students to understand and analyze a broad range of tasks around automation and robotics, to structure them and to find solutions in a systematic way.

4 Examination

The examination is a written exam (duration: 60 minutes) or an oral examination (duration: 30-45 minutes).

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Bickendorf	Faculty of Mechanical Engineering (7)

MMT-23: Finite Element Method I

Master-Program Manufacturing Technology
Section of Study: 1st / 3rd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Finite Element Methods I	L(2)+E(2)	English	WS	5	4

2 Content

The module focuses on the algorithm formulation of the finite element method and its implementation. The module content starts with the strong and weak form of the balance of linear momentum. This continuous representation of the equilibrium condition is transformed into a discrete boundary value problem by means of discretization and assembly operation. The students carry out essential steps of the implementation of the finite element method on their own and analyze different boundary value problems based on their self-written finite element program. Heat conduction and linear elasticity for the one- and two-dimensional case are considered as representative technical applications.

3 Competence

After successful participation, students are able to analyze complex mechanical systems, model and program technically relevant problems. Based on this implementation, students will be able to solve basic problems in applied mechanics via simulations. Furthermore, the students are able to apply alternative methods and approaches to engineering problems, to compare them with each other, to analyze their respective advantages and disadvantages and to decide on a preferred method specific to the application.

4 Examination

The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

Basic knowledge in programming as well as linear elasticity theory are recommended.

6 Module Type and Usability of the Module

Elective catalog

7 Representative of the Module	**Responsible Faculty**
Mosler	Faculty of Mechanical Engineering (7)

MMT-24: Finite Element Method II

Master-Program Manufacturing Technology **Section of Study:** 3rd semester							
Duration: 1 semester		**CP:** 5	**Workload:** 150 h				
			Attendance time: 45 h		**Self study:** 105 h		
1	**Module structure**						
	No.	**Element/Course**	**Type**	**Language**	**Cycle**	**CP**	**SWS**
	1	Finite Element Methods II	L(2)+E(2)	English	SS	5	4
2	**Content** At the beginning, the finite element based formulation of elastodynamic boundary value problems is treated by introducing terms such as the mass matrix. Explicit as well as implicit time integration methods are introduced and used to solve such problems. This is followed by an introduction to the modeling and algorithm implementation of nonlinear material behavior, in particular viscoelasticity and elastoplasticity. Finally, aspects of element technology are treated, in particular finite element formulations suitable for the simulation of incompressible material behavior.						
3	**Competence** After successful participation, students are able to analyze complex mechanical systems, model and program technically relevant problems. Based on this implementation, students will be able to solve basic problems in applied mechanics via simulations. Furthermore, the students are able to apply alternative methods and approaches to engineering problems, to compare them with each other, to analyze their respective advantages and disadvantages and to decide on a preferred method specific to the application.						
4	**Examination** The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment. ☒ Module examination ☐ Partial performance						
5	**Prerequisites** Basic knowledge in programming and linear elasticity theory are recommended as well as the module "Finite Element Methods I" are recommended.						
6	**Module Type and Usability of the Module** Elective catalog						
7	**Representative of the Module** Mosler			**Responsible Faculty** Faculty of Mechanical Engineering (7)			

MMT-25: Advanced Simulation Techniques in Metal Forming I

Master-Program Manufacturing Technology
Section of Study: 2nd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Advanced Simulation Techniques in Metal Forming I	L(2)+ E(2)	English	SS	5	4

2 Content

Finite element based modeling and simulation of forming processes involves some of the most complex aspects of continuum mechanics. These include large deformations in general, large plastic deformations in particular, contact problems, and process-induced elastic and inelastic anisotropy. Treating kinematics will start the theoretical framework. Furthermore, the balance equations and the main laws of thermodynamics are introduced. Various stress measures and stress rates are treated. Another elementary building block of continuum mechanics is material modeling. In this context, two fundamentally different methodologies, hyperelasticity and hypoelasticity, are discussed and extended to plasticity. The weak form of the balance equations are introduced as basis for the finite element method. The theoretical framework is then specifically applied to structural elements such as beams and shells as well as to contact problems.

3 Competence

After successful participation, students will be able to...

- name the elementary physical quantities and principles used in Nonlinear Continuum Mechanics as well as to explain their physical meaning and use them for calculations/ simulations.
- explain the term "thermodynamic consistency" and evaluate different models in this regard.
- name different structural elements and assess the related assumptions contextually. Furthermore, students will be able to decide in favor of certain structural elements and use them in FE simulations.
- explain the basic concepts for solving contact problems. Furthermore, they can name different mathematical procedures along with their respective advantages and disadvantages.
- independently prepare and perform finite element calculations using a commercial program.

analyze the obtained results and determine advantages/ disadvantages of different methods.

4 Examination

The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

Profound knowledge of mathematics and mechanics (undergraduate courses) is recommended. Basic knowledge of the finite element method (MMT module FEM I/II or equivalent) is also recommended, but not mandatory.

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Menzel	Faculty of Mechanical Engineering (7)

MMT-26: Advanced Simulation Techniques in Metal Forming II

Master-Program Manufacturing Technology
Section of Study: 3rd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Advanced Simulation Techniques in Metal Forming II	L (1.5) + E (1)+P(1.5)	English	WS	5	4

2 Content

After a short review of the fundamental basics, including sources of non-linearities, kinematics, constitutive models and balance relations, the course covers relevant topics of modern finite element (FE) software. Rigid-plastic material behavior is discussed along with aspects of explicit and implicit time integration. Numerical modeling is extended to thermo-mechanical simulations to enable the depiction of warm and hot forming processes. Analogously, heat generated by the material itself during forming operations is accounted for. Besides traditional modeling aspects such as contact and friction, developments from research in the field of damage and failure are incorporated. For all topics, verification and validation procedures are vital for simulation engineers to understand in order to use their FE based results as a basis for real-world decisions. The lecture further includes application-oriented examples.

The students learn to apply the theoretical concepts in the exercise, in which forming processes are analyzed using commercial FEM code. The critical questioning of chosen assumptions and boundary conditions is investigated using parameter studies. Results are analyzed and interpreted regarding their validity. An introduction to subroutine development and automated simulation analysis for advanced modeling beyond the standard tools, which is relevant for research and advance applications, is further provided.

3 Competence

After successful participation, students are able to...

- explain the derivation of various balance relations and their discretized version relevant for FE- analysis.
- choose the appropriate modeling approach (elasto-plastic, rigid-plastic, explicit/implicit time integration) for a given forming technology related problem.
- critically assess the influence of a chosen contact formulation.
- choose the appropriate material model regarding the requirements of a given problem.
- select and perform the verification and validation procedures in order to ensure transferability of their FE-based simulations.

critically reflect the results generated using different modeling techniques.

4 Examination

The examination consists of a combination of a written examination and/or oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

Basic knowledge of FEM (MMT module FEM I / II or equivalent, highly recommended: Advanced Simulation Techniques in Metal Forming I; Knowledge of strength of materials or introduction to continuum mechanics

6 Module Type and Usability of the Module

Elective catalog

7 Representative of the Module	**Responsible Faculty**
Korkolis	Faculty of Mechanical Engineering (7)

MMT-27: Introduction to Reliability Engineering

Master-Program Manufacturing Technology
Section of Study: 1st semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Introduction to Reliability Engineering	L(2)+E(2)	English	WS	5	4

2 Content

In this lecture series, students are taught the fundamental basics of risk engineering. This course starts with a general overview of what Risk-based engineering is, and how it complements traditional safety-factor driven design calculations. To complement the remainder of the lecture, the course builds the necessary theoretical foundations of probability theory, which are explained from an engineering perspective with emphasis on mechanical engineering applications. Then, the basics of qualitative risk assessment (FMEA, FMECA, HAZOP) are explained, which form the basis of performing a risk analysis. To make the step towards more complicated systems, Fault Tree and Event Tree Analysis are discussed in detail. Also, the step towards time-dependent reliability analysis and the effects of fatigue on the mechanical reliability are discussed. Finally, to make the students aware of the challenges that are associated with dealing with real-life engineering problems, the effects of including vague, dubious, conflicting or missing information on the analysis of reliability are discussed in detail.

3 Competence

Upon successful completion of this course, students will be able to understand the basic concepts of reliability-oriented design and apply them to a practical engineering case. Students will be able to perform a basic risk analysis of a mechanical component or system (such as a machine), and will be able to discuss the time-dependent reliability of a component under, e.g., fatigue loads.

4 Examination

The course examination consists of an oral examination with written preparation, and includes theoretical and practice questions.

☒ Module examination	☐ Partial performance

5 Prerequisites

Statistical bases are recommended.

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Faes	Faculty of Mechanical Engineering (7)

MMT-28: Advanced Methods for Reliability Engineering

Master-Program Manufacturing Technology
Section of Study: 2nd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Advanced Methods for Reliability Engineering	L(2)+E(1)+P(1)	English	SS	5	4

2 Content

In this lecture series, students are taught the fundamentals of "reliability-oriented design". First, the theoretical foundations of probability theory are explained from an engineering perspective, with emphasis on mechanical engineering applications. In a second step, the concepts of mechanical reliability are explained and (semi-) analytical methods are discussed to calculate the mechanical reliability of a component under mild assumptions. Since these (semi-)analytical approaches are not always tractable, advanced numerical calculation schemes are discussed in detail, including Monte Carlo simulation, Importance Sampling, Line Sampling and Subset Simulation. Finally, specialized topics such as surrogate modelling, sensitivity analysis and reliability-based design optimization are covered. The course provides students with important concepts and unique tools for designing and optimizing mechanical components with a quantified reliability.

3 Competence

Upon successful completion of this course, students will be able to understand the concepts of reliability-oriented design and apply them to a practical engineering case. Students will be able to implement, apply and analyze the results of advanced numerical methods for reliability-oriented design optimization and will also be able to make educated and quantified estimates of the reliability level of a designed component.

4 Examination

The course examination consists of (1) a presentation of the project work and (2) an oral defense of the project results in which the student's knowledge of the course content is evaluated.

☒ Module examination	☐ Partial performance

5 Prerequisites

Statistical bases are recommended.

6 Module Type and Usability of the Module

Elective catalog

7 Representative of the Module	**Responsible Faculty**
Faes	Faculty of Mechanical Engineering (7)

MMT-29: Additive Manufacturing

Master-Program Manufacturing Technology **Section of Study:** 1st/3rd semester							
Duration: 1 semester		**CP:** 5	**Workload:** 150 h				
			Attendance time: 60 h		**Self study:** 90 h		
1	**Module structure**						
	No.	**Element/Course**	**Type**	**Language**	**Cycle**	**CP**	**SWS**
	1	Additive Manufacturing	L(4)	English	WS	5	4
2	**Content** The lecture "Additive Manufacturing" (AM) describes the principles and characteristics along the process chain of the layer-wise production of components. As a part of the process chain the lecture deals at first with topics regarding the generation of manufacturing data, which is divided into the steps of data preparation, data conditioning and data processing. One of the main emphases of the lecture is the description and explanation of the most important AM process categories on which commercially available technologies are based on. These include Powder bed fusion, Vat photopolymerization, Material jetting, Material extrusion, Binder jetting, Sheet lamination and Directed energy deposition. As additional contents various methods for post-processing of components are discussed in the lecture as well as the cost-effectiveness depending on different factors.						
3	**Competence** Students learn the basics and applicational fields of Additive Manufacturing processes based on DIN EN ISO 52900. In addition to the basics, practical and technical knowledge is provided for the proper selection of the manufacturing process, the preparation of the component and the selection of the appropriate manufacturing process.						
4	**Examination** Written Exam ☒ Module examination ☐ Partial performance						
5	**Prerequisites** None						
6	**Module Type and Usability of the Module** Elective catalog						
7	**Representative of the Module** Sehrt			**Responsible Faculty** Faculty of Mechanical Engineering (7)			

MMT-30: Measurement Engineering

Master-Program Manufacturing Technology
Section of Study: 1st semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Measurement Engineering	L(2.5)+E(1.5)	English	WS	5	4

2 Content

This course introduces students to the measurement chain in any manufacturing process by illustrating the path of the measurement signal stepwise from recording to measuring the variable. The course conveys basic concepts and principles of measurement engineering, from measurement methods and sensors in different production fields to data processing by statistical analysis of the measured output to design of experiments. Then the metrology concepts in production measurement technology are treated followed by the application of learned techniques in materials and component testing. Data acquisition and control is an integral part of the course. In interactive lessons, students learn to use the visual programming environment LabVIEW to visualize, create, and code engineering measurement systems. Finally, students are introduced to statistical techniques used in test planning, analysis, and optimization of engineering systems.

3 Competence

Students master basic theoretical and mathematical concepts for process and product optimized selection of appropriate measurement methods and transducers, of measurement in manufacturing and in materials and component testing, of data acquisition and processing and for statistical analysis and design of experiments. Students are able to identify specific problems and possible solutions to deal with this offer. Accompanying exercises expand the students´ competencies by improving their analytical thinking, communication, and team skills. Furthermore, they are prepared for further self-studies.

4 Examination

Written or oral exam

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Elective catalog

7 Representative of the Module	**Responsible Faculty**
Walther	Faculty of Mechanical Engineering (7)

MMT-31: Fatigue Behavior

Master-Program Manufacturing Technology
Section of Study: 2nd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Fatigue Behaviour	L(2.5)+E(1.5)	English	SS	5	4

2 Content

In addition to materials science aspects of fatigue behavior of metals, the standard of knowledge on relationship between microscopic structure and macroscopic properties is imparted. The characterization of fatigue behavior is performed by mechanical, thermal, electrical and magnetic measurement techniques and transducers. Current fatigue damage accumulation hypothesis and life time calculation approaches are presented. All the stages of fatigue life - crack initiation, crack propagation and final failure - are dealt with the corresponding mechanisms. To understand and correlate the mathematical models in material fatigue and experimental studies, finite element simulations are introduced. Abaqus and nCode programmes are used for understanding of classical fatigue models and promotes to develop the application-oriented models. Tutorials are designed to simulate fatigue life of different industrial components.

3 Competence

Students gain assessment competence for the independent selection of engineering materials on the basis of given component requirements as well as for the targeted use of introduced methods for material characterization. Students´ cross-disciplinary thinking in overall contexts is encouraged and students are able to identify specific problems and possible solutions to deal with this offer. Through accompanying exercises students expand their analytical skills and develop teamwork and communication skills as well as are prepared for further self-studies.

4 Examination

Written or oral exam

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Walther	Faculty of Mechanical Engineering (7)

MMT-32: Machining Process Simulation

Master-Program Manufacturing Technology
Section of Study: 1st semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Machining Process Simulation	L(3)+ E(1)	English	WS	5	4

2 Content

A detailed insight into machining processes is the most important precondition to understand their principle working mechanisms and, hence, to use this knowledge for their planning and optimization. For this reason, modeling and simulation approaches which are capable of deriving predictions for different process values are in the focus of this lecture. Today, such process simulation systems are subject to research on the one hand but they are applied in industry to a certain extend as well, which is mainly driven by the availability of low cost computational power. This lecture deals with the modeling and simulation of machining processes (mainly turning and milling), focusing on the processes themselves. Starting with a definition and classification of different modeling methods such as analytical-empirical, finite-element-based and geometrical-physical, these methods are explained successively. Their working principles are outlined, but restrictions and boundary conditions are discussed as well. Also, one or two systems are presented in live demonstrations.

3 Competence

The students have an overview of different existing modeling concepts for the simulation of machining processes. They have knowledge about the working principles of these models and of the realization of some of the models in software tools as well. With this knowledge, they are enabled to choose appropriate modeling concepts for the simulation of specific machining processes, with respect to accuracy, efficiency and reliability. In addition, they can assess the validity calculated simulation results.

4 Examination

Written exam

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Zabel	Faculty of Mechanical Engineering (7)

MMT-33: Basics of Materials Technology

Master-Program Manufacturing Technology
Section of Study: 1st semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 40 h	**Self study:** 110 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Basics of Materials Technology	2(L) + 2 (E)	English	WS	5	4

2 Content

This course aims at refreshing and strengthening knowledge in the field of materials engineering and materials technology. The focus lies on the structures of metallic, inorganic, and organic materials, their mechanical, chemical and diffusion properties as well as their processing and fields of application. Be-sides steel, other metallic and non-metallic materials will be discussed and analyzed. Within a practical section, the students will select materials for a specific application within the context of a case study. The course will also provide fundamental insights into the field of material testing and material analysis.

3 Competence

After successful participation in this module, students will be able to name the different basic groups of materials and to explain the respective material properties based on the underlying basic mechanisms. The students will be able to apply the knowledge they have acquired, e.g. to select suitable materials for a construction or to explain or evaluate a specific material selection.

4 Examination

The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

None

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Tillmann	Faculty of Mechanical Engineering (7)

MMT-34: Parameter Identification

Master-Program Manufacturing Technology
Section of Study: 2^{nd} semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Parameter Identification	L(2)+E(2)	English	SS	5	4

2 Content

Modeling the behavior of materials requires the definition of a physical model, which is transformed into the formulation of a mathematical model. The resulting mathematical models are usually very complex and are therefore generally solved numerically. To this end, algorithmic methods are addressed that allow the material parameters of such models to be identified from experimental data using optimization problems. The basic theoretical and algorithmic concepts of constrained and unconstrained nonlinear optimization required for this purpose are discussed. Both gradient-based and gradient-free methods are considered. While the initial focus is on homogeneous problems, the methods for inhomogeneous problems are also discussed at the end. In the exercises of this module, the focus is placed on programming of the discussed models and methods.

3 Competence

After successful participation, students are able to name methods of parameter identification and apply them to technically relevant problems. Furthermore, the students are able to apply the different methods and approaches, to compare them with each other, to analyze their respective advantages and disadvantages and to decide for a preferred method specific to the application.

4 Examination

The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

Basic knowledge in programming as well as the modules “Introduction to Theory of Materials”, and “Tensor Calculus” are recommended.

6 Module Type and Usability of the Module

Elective catalog

7 Representative of the Module	**Responsible Faculty**
Mosler	Faculty of Mechanical Engineering (7)

MMT-35: Finite Inelasticity

Master-Program Manufacturing Technology
Section of Study: 1st/3rd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Finite Inelasticity	L(2)+E(2)	English	WS	5	4

2 Content

The prediction of the inelastic behavior of materials requires the definition of a physical model and its transformation into a mathematical formulation. This approach to material modeling is the focus of the course. The focus is on the one hand on the consideration of finite deformations and on the other hand on the description of inelastic material behavior. The material modeling is embedded in the framework of continuum thermodynamics and deals with the theoretical modeling of and the algorithm implementation of, e.g., plasticity for single crystals and polycrystals.

3 Competence

After successful participation, students are able to name methods for material modeling in finite inelasticity and apply them to technically relevant problems. Furthermore, the students are able to apply alternative methods and approaches, to compare them with each other, to analyze their respective advantages and disadvantages and to decide on a preferred method specific to the application. Students are also able to evaluate and develop mathematical models.

4 Examination

The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

Basic knowledge in programming as well as the modules “Introduction to Theory of Materials” and “Tensor Calculus” are recommended.

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Mosler	Faculty of Mechanical Engineering (7)

MMT-36: Non-linear Continuum Mechanics

Master-Program Manufacturing Technology
Section of Study: 2nd semester

Duration: 1 semester	**CP:** 5	**Workload:** 150 h	
		Attendance time: 45 h	**Self study:** 105 h

1 Module structure

No.	Element/Course	Type	Language	Cycle	CP	SWS
1	Non-linear Continuum Mechanics	L(2)+E(2)	English	SS	5	4

2 Content

The lecture covers the fundamentals and engineering applications of continuum mechanics for geometrically nonlinear and spatially three-dimensional problems of solids. Central topics of the module are the kinematics of finite deformations, the thermodynamic balance equations and the material equations for the description of material behavior. In the exercises of this module, the focus is the implementation of the methods discussed.

3 Competence

After successful participation, students are able to name the basic concepts of continuum mechanics for general nonlinear problems and to transfer and apply them to relevant problems and solve them.

4 Examination

The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment.

☒ Module examination	☐ Partial performance

5 Prerequisites

Basic knowledge in programming as well as the modules “Introduction to Theory of Materials” and “Tensor Calculus” are recommended.

6 Module Type and Usability of the Module

Elective catalog

7

Representative of the Module	**Responsible Faculty**
Mosler	Faculty of Mechanical Engineering (7)

MMT-37: Non-linear Finite Element Methods

Master-Program Manufacturing Technology **Section of Study:** $1^{st}/3^{rd}$ semester							
Duration: 1 semester		**CP:** 5	**Workload:** 150 h				
			Attendance time: 105 h		**Self study:** 45 h		
1	**Module structure**						
	No.	**Element/Course**	**Type**	**Language**	**Cycle**	**CP**	**SWS**
	1	Non-linear Finite Element Methods	L(2)+E(2)	English	WS	5	4
2	**Content** The lecture covers the fundamentals and engineering applications of the finite element method for geometrically nonlinear and spatially three-dimensional problems of elastic solids. At the beginning of the module, the balance equations are introduced in weak form and in terms of different configurations. Subsequently, these forms are discretized domain-wise. To solve the resulting discrete nonlinear system of equations using Newton's method, the corresponding tangent operator is derived and the algorithmic formulation of the treated finite element method is explained. In addition to hyperelasticity, the finite element modeling of thermoelastodynamics is also treated. In addition, special solution methods such as arc length methods are discussed. In the exercises of this module, the focus is on the programming of the methods discussed.						
3	**Competence** After successful participation, the students are able to name the basic concepts of the finite element method for nonlinear problems and to transfer and apply those to relevant problems of continuum mechanics as well as to solve them. Furthermore, students design parts of a finite element program.						
4	**Examination** The examination consists of a written examination or a combination of oral examination and/or presentation and/or project assignment. ☒ Module examination ☐ Partial performance						
5	**Prerequisites** Basic knowledge in programming as well as the modules "Finite Element Method I", "Finite Element Method II", "Introduction to Theory of Materials" and "Tensor Calculus" are recommended.						
6	**Module Type and Usability of the Module** Elective catalog						
7	**Representative of the Module** Menzel			**Responsible Faculty** Faculty of Mechanical Engineering (7)			

MMT-38: Quality Management

Master-Program Manufacturing Technology **Section of Study:** 1st semester/ 3rd semester							
Duration: 1 semester	**CP:** 5	**Workload:** 150 h					
		Attendance time: 45 h	**Self study:** 105h				

1	**Module structure**						
	No.	**Element/Course**	**Type**	**Language**	**Cycle**	**CP**	**SWS**
	1	Quality Management	L(2)+P(2)	English	WS	5	4

2 Content

This course provides students with the basics of quality management in the broadest sense and serves as a foundation for more advanced courses on specific quality management topics. The course topics covered in detail are:
- Introduction to statistics and probability theory to provide the necessary tools for dealing with the rest of the course material.
- Description and design of measurement systems
- A selection of the viewpoints of the quality gurus from a historical perspective
- Acceptance sampling in quality control and a comparison of the different perspectives
- Statistical process control and control charts
- Incorporating quality aspects into the design of components
- Quality management systems: ISO9001, Six Sigma, Total Quality Management, etc.

The course concludes with a seminar given by a person from industry, depending on availability. In parallel with the lectures, students work individually or in small groups on a practical case study, applying the concepts learned to a practical quality management problem.

3 Competence

Upon successful completion of the course, students should have a thorough understanding of the various quality management concepts as described in the course content and be able to perform basic quality management analysis and decision making incorporating the concepts taught.

4 Examination

Written examination of max. 2 hours, consisting of theoretical questions and exercise tasks (75%).
Project report of the group work describing the description and results of the case study (25%)

☒ Module examination	☐ Partial performance

5 Prerequisites

none

6 Module Type and Usability of the Module

Elective catalog

7	**Representative of the Module** Faes	**Responsible Faculty** Faculty of Mechanical Engineering (7)