Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Core module Advanced Manufacturing

Module number	1.1
Module name	Mathematics for Engineering Science
Module responsibility	Dean of Mathematics of the Faculty of Mathematics
Content and qualification goals	Contents: The module focuses on the following topics: • Linear algebra (linear mappings, systems of equations, eigenvalues) • Power series, Taylor series and Fourier series • Differential and integral calculus (one- and multidimensional) • Ordinary differential equations Qualification goals: The goal of the module is to achieve a uniform level of practically applicable knowledge of mathematics. This requires an understanding of terms, structures and methods. Students are put in a position to do so, to translate engineering science questions into mathematical language and to solve them. The qualification goal of the internship is the acquisition of methods and procedures for the independent application of mathematical concepts and methods.
Teaching forms	Lectures and exercises are the teaching forms of the module are E (Exercise) and P (practical course) • E: Mathematics for Engineering Science (2 LVS) • P: Mathematics for Engineering Science (2 LVS)
Prerequisites for participation (recommended knowledge and skills)	None
Availability of the module	---
Requirements for the award of credit points	The fulfilment of the admission requirements for the examination performance and the successful completion of the module examination are requirements for the award of credit points. Admission requirement is the following preliminary examination (can be repeated indefinitely): • Processing of 4-7 task complexes for the practical course Mathematics for Engineering Science, which must be passed individually. Passed means that at least 50% of the evaluation points have been achieved.
Module examination	The module examination consists of an examination performance: • 120-minute exam on Mathematics for Engineering Science (exam number: 20096)
Credit points and grades	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations
Frequency of module	The module is offered every academic year in the winter semester.
Workload	The module comprises a total workload of 150 AS for the students.
Duration of the module	If the course of studies is regular, the module lasts one semester. The module is offered as a block course in the first half of the semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Core module Advanced Manufacturing

Module number	1.2
Module name	Digital Manufacturing
Responsible for the module	Professorship Production Systems and Processes
Contents and qualification objectives	Content: Modern industrial production is characterized by the intensive use of information and communication technology. The basis for this are intelligent and digitally connected systems. The module covers the basic knowledge of a digitalized and connected production in the value-added chain and illustrates corresponding fields of application. Students will learn the essential basic components of digital production and how these are used in the context of Industry 4.0. This includes the machine (basics of NC/CNC as well as CAD/CNC process chain, design of a machine tool, control types, MDE and DNC systems), the use of virtual and augmented reality in development and production up to models and methods of the digital factory. The theoretical knowledge is complemented by practical seminars in the individual areas. A supporting insight into the practical application of digital and connected production is provided by excursions to innovative industrial companies. Qualification Goals: After successfully completing the module, students are able to • describe the operation of an NC axis and the reference points in the working space of a machine tool, to create NC programs for geometrically simple parts manually and to explain CAD/CAM(NC) process chains of practical relevance. • prepare CAD models for use in the Virtual and Augmented Reality applications and deriving corresponding scenarios • differentiate methods and aspects of the digital factory. • analyze an existing production facility and identify potentials for the use of digitalization methods.
Teaching formats	The Module contains lectures (L) and seminars (S). • L: Digital Manufacturing (2 LVS) • S: Digital Manufacturing (2 LVS)
Preconditions for participation (recommended knowledge and skills)	• Basic knowledge of machine tools • Basic knowledge of CAD tools • Basic programming knowledge (C#)
Applicability of the module	---
Preconditions for the award of credit points	The successful passing of the examination: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • 120-minute written examination (number 33640)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Core module Advanced Manufacturing

Module number	1.3
Module name	Additive Manufacturing
Responsible for the module	Professorship of Print Media Technology
Contents and qualification objectives	Contents: The course gives an overview of the technologies of additive manufacturing. The lecture includes: Systematics and overview of subtractive and additive processes, coating and structuring, layer formation, 2D / 3D, process chains, functionalization, materials and requirements, comparison of different processes, applications. The Additive Manufacturing I lecture focuses on liquid-based processes and the Additive Manufacturing II lecture focuses on solid-based processes. The seminar includes patent research on specified issues in the field of additive manufacturing. After instruction and introduction to the patent databases and search strategies, each student receives a topic for independent patent research. Qualification objectives: The student should gain a deep understanding of the systematics, function and application scenarios of modern and current technologies in the field of additive manufacturing. He should be empowered to penetrate the field of engineering science.
Teaching formats	The teaching format are lectures (V), lab courses (P) and seminar (S) • V: Additive Manufacturing I (2 LVS) • V: Additive Manufacturing II (1 LVS) • S: Additive Manufacturing (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. These requirements are: • Module 1.1 Mathematics for Engineering Sciences And the following prerequisites for admission (can be repeated infinitely): • Patent report (length: at least 5 pages, processing time: 8 weeks) for the seminar Additive Manufacturing
Module examination	The module examination consists of: • 20 minutes oral examination on Additive Manufacturing (Examination number: 31337).
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester. The module is offered as a block course in the second half of the semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Core module Advanced Manufacturing

Module number	1.4
Module name	Resource Efficiency from an Economic Perspective
Responsible for the module	Chair of Management Accounting and Control
Contents and qualification objectives	Contents: Firstly, the course provides an overview of the integration of resources and resource efficiency in management theory. Thereafter, basing on the discipline-specific terms of resources and efficiency, methods of management accounting are presented which enable the determination and analysis of resource demand and, thus, also support the evaluation and controlling of resource efficiency. Specific topics are, among others: • Resources and resource efficiency in management theory • Production and cost theory • Cost accounting • Investment appraisal • Selected approaches of cost management Qualification objectives: Participants become acquainted with management view on resources and resource efficiency and they acquire specific knowledge in particular with regard to methods of management accounting and cost management.
Teaching formats	The teaching forms of the module are lecture and exercise. • V: Resource Efficiency from an Economic Perspective (2 LVS) • Ü: Resource Efficiency from an Economic Perspective (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. These requirements are: • Module 1.1 Mathematics for Engineering Sciences
Module examination	The module examination consists of: 90 minutes written examination about printing and processes I (Examination number: 61424)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150.AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Supplementary module Research Methods and Soft Skills

Module number	2.1
Module name	Research Methods
Responsible for the module	Professorship Sports Equipment and Technology
Contents and qualification objectives	Contents: The module conveys the basic principles of scientific work in the field of Engineering Sciences. Handling of literature sources, collection and analysis of experimental data as well as guidelines for the publication of scientific findings (articles, posters, theses) will be treated. Qualification objectives: The students acquire the key principles of scientific works (e.g. philosophy of science, scientific ethics) and deploy them to write their own scientific work. They can structure a scientific article or their final thesis independently. After successful attendance of the course, the students are capable of handling scientific data correctly (e.g. collection, storage, analysis, presentation).
Teaching formats	The module's type of course is the seminar. • S: Research Methods (2 LVS)
Requirements for participation (recommended knowledge and skills)	None
Applicability of the module	---
Requirements for the award of credit points	Successfully passing the module exam is the requirement for earning credit points.
Module examination	The module examination consists of: • Scientific abstract (length: 4 pages, processing time: 8 weeks) on research methods (examination number: 2110)
Credit points and marks	2 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module will be offered in the summer semester of every other academic year.
Workload	The module comprises a student´s workload of 60 WH (working hours).
Duration of the module	In a regular course of studies, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Supplementary module Research Methods and Soft Skills

2.2 – 2.13 not yet available, please see German version

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Hybrid Technologies, supplementary module Elective Courses

Module number	3.1.1
Module name	Textile Process Chains
Responsible for the module	Professorship of Textile Technologies
Contents and qualification objectives	Contents: The module teaches the basics of the processes for the production of textile reinforcement structures for high-performance fibre-plastic composites. The focus is on the different textile thread and surface manufacturing processes and their individual potentials for the variation/adjustment of composite properties. The conceptual and physical principles of thread formation from filament and staple fibers are taught and the relationships between fiber parameters, spinnability and properties of the produced thread materials are explained. The further processing of the thread materials into textile surfaces is carried out in the form of woven fabrics, braids, knitted fabrics and nonwovens. The technological principles of these manufacturing processes and the physical requirements for processing the high-performance yarn materials are presented and, based on this, the differences between the various processes with regard to the resulting material properties are worked out. Thus, the prerequisites for the understanding of process- or process parameter-specific effects on thread, surface and especially the resulting composite properties are created. Qualification objectives: The students acquire basic knowledge of thread production and an overview of the technologies of common surface forming processes. The general textile-physical and technological basics imparted enable the students to evaluate the effects of modifications to the textile materials on the resulting composite properties.
Teaching formats	Teaching forms of the module are lecture and practical training. • V: Textile Process Chains (2 LVS) • P: Textile Process Chains (1 LVS)
Requirements for participation (recommended knowledge and skills)	None
Applicability of the module	---
Requirements for the award of credit points	The fulfillment of the admission requirements for the examination and the successful completion of the module examination are prerequisites for the award of credit points. Admission requirement is: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of an examination paper: • 90-minute written examination on Textile Process Chains (examination number: 34004))
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module will be offered in the summer semester of every other academic year.
Workload	The module comprises a student´s workload of 150 WH (working hours).
Duration of the module	In a regular course of studies, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Hybrid Technologies, supplementary module Elective Courses

Module number	3.1.2
Module name	Applied Modelling and Simulation in Solid Mechanics I
Responsible for the module	Professorship of Solid Mechanics
Contents and qualification objectives	Contents: The module first covers the fundamentals of linear continuum mechanics and material modeling. This is followed by an introduction to the linear finite element method, with the emphasis on the application of commercial FEM programs. • Representation and calculation rules of tensors • Invariants, Eigenvalues and Eigenvectors • Distortion and voltage tensors • Rheological substitute models, elasticity, viscoelasticity • Solution algorithm of linear FEM • Element types and numerical integration Qualification objectives: After successful completion of the module, students are able to calculate problems in solid-state mechanics and thus perform the tasks of a development and calculation engineer in the field of computer-aided component simulation.
Teaching formats	Teaching forms of the module are lecture and exercise. • V: Applied Modelling and Simulation in Solid Mechanics I (2 LVS) • Ü: Applied Modelling and Simulation in Solid Mechanics I (2 LVS)
Requirements for participation (recommended knowledge and skills)	At least two semester lecture on technical mechanics
Applicability of the module	---
Requirements for the award of credit points	The fulfillment of the admission requirements for the examination and the successful completion of the module examination are prerequisites for the award of credit points. Admission requirement is: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of an examination paper: • 30-minute oral exam on Applied Modelling and Simulation in Solid Mechanics I (examination number: 31819) The exam can be taken in German or English.
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module will be offered in the summer semester of every other academic year.
Workload	The module comprises a student´s workload of 150 WH (working hours).
Duration of the module	In a regular course of studies, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile areas Hybrid Technologies, Printed Functionalities, supplementary module Elective Courses

Module number	3.1.3, 3.2.3
Module name	Surface and Interface Engineering
Responsible for the module	Professorship Materials and Surface Engineering
Contents and qualification objectives	Contents: The module includes the topics surface and coating technology as well as the interface design in hybrid material compounds. Thereby, emphasis is put on the comprehension of the relations between process, (micro)structure and properties. Knowledge is provided about all major processes for the production of metallic, inorganic-nonmetallic and organic coatings and surface structures. Under consideration of the complex requirement profile of surfaces and interfaces due to mechanical, tribological, corrosive and thermal loads, design strategies to meet these requirements are presented. Qualification objectives: The students know the chemical, physical and technological fundamentals of the essential processes of surface or coating technology including important pre- and post-treatment processes. They recognize and understand the fundamental relationships between the process characteristics and the resulting structures and properties of the coatings. They are able to select coating systems based on the application and to justify their selection in a well-founded manner.
Teaching formats	Teaching formats of the module are Lecture (V), Seminar (S) and Practical Course (P) • V: Surface and Interface Engineering (2 LVS) • S: Surface and Interface Engineering (1 LVS) • P: Surface and Interface Engineering (1 LVS)
Preconditions for participation (recommended knowledge and skills)	Basic knowledge about chemical bonds, atomic structure, periodic table of elements, structure of crystalline materials, corrosion and wear
Applicability of the module	---
Preconditions for the award of credit points	The fulfillment of the requirements for the exam admission and passing the module exam are preconditions for the award of credit points. Exam admission requirements are: • Module 1.1 Mathematics for Engineering Science and the following obligatory prerequisite (infinitely repeatable): • 20-minute presentation within the seminar
Module examination	The module examination consists of: • 90-minute written exam on Surface and Interface Engineering (examination number: 32510)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile areas Hybrid Technologies, Production Systems, supplementary module Elective Courses

Module number	3.1.4, 3.4.8
Module name	Complex Materials for Manufacturing
Responsible for the module	Professorship of Composites and Material Compounds
Contents and qualification objectives	Contents: The increasing complexity of product requirements increasingly calls for the use of modern material solutions. In addition to ceramic and metallic construction materials, composite materials and material composites are becoming increasingly important. As a single material often does not fully meet the required property profile, the development of suitable material combinations and the development of new manufacturing technologies are essential. Complex designed material systems occupy a key position and are of fundamental importance on the growth markets. Tailor-made materials for lightweight construction and high-temperature applications are in demand. To this end, new joining and composite concepts must be developed for a wide variety of material groups. This requires material-specific knowledge and correlation skills as well as the design of manufacturing technologies. In the module, the development and use of metallic, ceramic and glass-like lightweight, high-temperature and composite materials are discussed in particular and the importance of these material groups for the production of customized material solutions is elaborated. Students will first receive an overview of the definitions of terms. Materials science fundamentals with reference to the materials under consideration are explained, and the properties and application potential are discussed. Furthermore, the suitable combination of materials to form material composites by means of innovative manufacturing processes is dealt with. In the practical course, students gain an insight into the manufacture and characterization of ceramic and metal-based composites. Qualification objectives: Students will be able to confidently use the terms metal, ceramic, glass, composite and material composite, explain common manufacturing processes and characterize the properties. In addition, students have demonstrated the necessary expertise to confidently assess the application potential of metallic, ceramic and glass-like lightweight materials and their composite solutions. They will be able to identify challenges in joining dissimilar materials and propose appropriate joining solutions. Likewise, students are able to evaluate and apply manufacturing and testing methods with regard to the opportunities and limitations of these material groups.
Teaching formats	Learning methods of the module are Lecture (L) and Internship (I). • L: Complex Materials for Manufacturing (2 LVS) • I: Complex Materials for Manufacturing (1 LVS)
Preconditions for participation (recommended knowledge and skills)	Fundamentals of Materials Engineering
Applicability of the module	---
Preconditions for the award of credit points	The fulfilment of the admission requirements for the examination and the successful completion of the module examination are prerequisites for the award of credit points. The admission requirement is: • Module 1.1 Mathematics for Engineering Science

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Module examination	The module examination consists of: • 120-minute exam on Complex Materials for Manufacturing (examination number: 33319) The examination language is English. On request, in exceptional cases, the examination performance can be provided in German.
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Hybrid Technologies, supplementary module Elective Courses

Module number	3.1.5
Module name	Calculation of Anisotropic Composite Materials
Responsible for the module	Professorship of Lightweight Structures/Polymer Technology
Contents and qualification objectives	Contents: In the first step of the course, the basics of elasticity theory for anisotropic material behavior of the single layer will be taught in order to derive the multilayer theory. Multilayer composites of fiber-reinforced materials represent future-oriented lightweight construction solutions, especially in the aerospace, innovative vehicle construction and general mechanical engineering. Using classical laminate theory as a mathematical tool, students will learn to understand the complex stress and deformation behavior of flat surface structures made of fiber-reinforced plastics (FRP) as a result of mechanical, thermal and media-related loads. In addition, general and fracture mode-related failure hypotheses will be taught, which are applied in different design concepts. Qualification objectives: After successful completion of the module, students are able to calculate components and structures made of a material with anisotropic material behavior. This enables them to determine a structural behavior for multi-layer composites that is suitable for loading by means of targeted layer orientation and targeted layer build-up.
Teaching formats	Teaching formats of the module are lecture and seminar. • V: Calculation of Anisotropic Composite Materials (2 LVS) • S: Calculation of Anisotropic Composite Materials (1 LVS)
Preconditions for participation (recommended knowledge and skills)	Basics of mathematics, physics and technical mechanics
Applicability of the module	---
Preconditions for the award of credit points	Fulfilment of the admission requirements for the examination and successful completion of the module examination are prerequisites for the award of credit points. The admission requirement is: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • 90-minute exam on Calculation of Anisotropic Composite Materials (examination number: 33147)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a student workload of 150 AS (working hours).
Duration of the module	In a regular course of study, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile areas Hybrid Technologies, Production Systems, supplementary module Elective Courses

Module number	3.1.6, 3.4.7
Module name	Composite-based Hybrid Technologies
Responsible for the module	Professorship Lightweight Structures/Polymer Design
Contents and qualification objectives	Contents: Cost-efficient large-scale technologies for the production of hybrid composite components are crucial for the industrial use of lightweight materials. In the lectures of the module, composite materials are classified and their structure and manufacture are explained. Knowledge of fibers, textile structures and polymer matrices, their production and use in fiber-reinforced plastics, load-appropriate and selected with regard to reinforcing effect, strength behavior and substance utilization, is acquired. Efficient technologies for the production of thermoset and thermoplastic polymer matrix composite semi-finished products and components are explained and compared. Based on this, the processing of polymer matrix composites in mixed designs and in hybrid structures is explained and characterized. The aspect of recycling is considered. Numerous practical applications are demonstrated by way of example, and the fundamentals of test methods are taught and discussed. In the exercises, methods for determining material parameters are discussed and micromechanical calculations are explained. Based on this, macromechanical theories and formulas are discussed and compared. A thermoset-based textile semi-finished product is manufactured and mechanically tested, and the methods of manufacturing textile-reinforced thermoplastic components are demonstrated and explained in the laboratories. Qualification objectives: The students have demonstrated a comprehensive knowledge of the design and use of hybrid composite structures, their technologies for manufacturing and processing, the resulting component properties including suitable measurement and testing methods. The students are able to apply their acquired expertise in a focused and targeted manner for the development of high-performance lightweight components.
Teaching formats	Teaching formats of the module are lecture and seminar. • V: Composite-based Hybrid Technologies (2 LVS) • S: Composite-based Hybrid Technologies (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Fulfilment of the admission requirements for the examination and successful completion of the module examination are prerequisites for the award of credit points. The admission requirement is: • Module 1.1 Mathematics for Engineering Science and the following preliminary examination (can be repeated indefinitely): • 2 passed tasks in the exercise Composite-based Hybrid Technologies. Passed means that for each at least 50% of the evaluation points have been achieved.
Module examination	The module examination consists of: • 90-minute exam on Composite-based Hybrid Technologies (examination number: 33144)

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a student workload of 150 AS (working hours).
Duration of the module	In a regular course of study, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Hybrid Technologies, supplementary module Elective Courses

Module number	3.1.7
Module name	Polymer-based Hybrid Structures
Responsible for the module	Professorship Lightweight Structures/Polymer Design, Professorship of Coordination Chemistry
Contents and qualification objectives	Contents: The course teaches the basics of bio-based plastics from the raw material basis and synthesis, processing to their properties and applications. In addition, the knowledge transfer on bio-based composites is based on the extraction of natural fibers and their properties as well as natural fiber semi-finished products and compounds, their processing into composite components up to their disposal and recycling. In addition, students will be taught the basics for the design of the fiber-matrix interface, which are decisive for the quality and properties of fiber-plastic composites. The course offers an overview of the physical and chemical properties of textile surfaces or matrix interfaces, the possibilities of targeted activation, functionalization and modification of the outer material layers as well as material combinations and their compatibility. Practical courses on the processing of bio-based plastics and composites and on the exemplary determination of physical and chemical surface properties complete the curriculum. Qualification objectives: Students acquire knowledge about the structure and processing of bioplastics and bio-based composites as well as their resource efficiency and sustainability. Students also acquire knowledge about adhesion improvement up to the targeted boundary layer design for fiber-reinforced plastic composites. So, they are able to make statements on fiber-matrix adhesion and to influence this in a targeted manner. Thus, the future graduates can be employed in the production process as well as in research and development.
Teaching formats	Teaching formats of the module are lecture and seminar. • V: Polymer-based Hybrid Structures (2 LVS) • S: Polymer-based Hybrid Structures (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Fulfilment of the admission requirements for the examination and successful completion of the module examination are prerequisites for the award of credit points. The admission requirement is: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • 90-minute exam on Polymer-based Hybrid Structures (examination number: 33146)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a student workload of 150 AS (working hours).
Duration of the module	In a regular course of study, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile modules profile areas Hybrid Technologies, Production Systems, supplementary module Elective Courses

Module number	3.1.8, 3.4.2
Module name	Process Chains for Sheet Metal and Bulk Metal Forming
Responsible for the module	Professorship for Forming and Joining
Contents and qualification goals	Contents: Knowledge is imparted on the design and evaluation of process chains for components that can be manufactured by sheet metal and bulk metal forming technologies. In addition to the forming processes upstream and downstream processes such as component heating, trimming and inductive joining are also considered. Depend- ing on the number of pieces to be produced and the variety of variants, convention- al and alternative process routes are developed, knowledge of the specifics of the forming tools is imparted and, in particular, the influence of individual process parameters such as temperature and speed is demonstrated. The kinematics of the forming machine are also dealt with. Qualification goals: After completion the module the students will be able to: • develop process chains for sheet and bulk metal parts by consideration of the production quantity, • describe the characteristics of process chains for cold and hot forming, • point out the variety of process chains and their evaluation under the aspects of resource efficiency and flexibility, • derive the requirements on forming tools depending on the stresses during forming, • explain the influence of the kinematic behavior of the machine by using different motion profiles and • propose and discuss activities to ensure the process reliability.
Teaching forms	Teaching forms of the module are lectures (V), exercises (Ü) and practical training (P). • V: Process Chains for Sheet Metal and Bulk Metal Forming (2 LVS) • Ü: Process Chains for Sheet Metal and Bulk Metal Forming (1 LVS) • P: Practical training (1 LVS)
Requirements for participation	Knowledge of production engineering
Applicability of the module	---
Requirements for the award of credit points	Successful completion of the module examination is a prerequisite for the award of credit points.
Module examination	The module examination consists of one examination performance: • 120-minute written examination
Credit points and marks	In this module 5 credit points are acquired. The assessment of the examination performance and the formation of the module mark are regulated in § 10 of the examination regulations.
Frequency of offer	The module is offered every academic year in the winter semester.
Workload	The module comprises a total student workload of 120 working hours.
Duration of the module	In the case of a regular course of study, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Printed Functionalities, supplementary module Elective Courses

Module number	3.2.1
Module name	Printing Processes
Responsible for the module	Professorship of Print Media Technology
Contents and qualification objectives	Contents: The course provides an overview of processes in the area of printing processes. The lecture includes: Systematics and overview of the process stages and process variants, printing form production, imaging, conventional printing processes, digital printing processes, print finishing, drying and layering, print quality, application scenarios and requirements, process characteristics. The lab courses include: The students make practical tests on printing machines. Print samples are produced and evaluated and the influence of the process characteristics is examined. Qualification objectives: Die Studenten haben ein tiefes Verständnis der Systematik, Funktion und Anwendungsszenarien der modernen und aktuellen Druckverfahren nachgewiesen. Sie sind zur ingenieurwissenschaftlichen Durchdringung des Stoffgebietes befähigt.
Teaching formats	The teaching format are lectures (V) and lab courses (P). • V: Printing and Processes (2 LVS) • P: Printing and Processes (2 LVS)
Preconditions for participation (recommended knowledge and skills)	Base module 1.1 to 1.4
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. These requirements are: • Module 1.1 Mathematics for Engineering Sciences And the following prerequisites for admission (can be repeated infinitely): • Successfully certified lab course
Module examination	The module examination consists of: • 90-minute written examination on Printing Processes (examination number: 31340).
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Printed Functionalities, supplementary module Elective Courses

Module number	3.2.2
Module name	Printed Electronics & Special Topics of Functional Printing
Responsible for the module	Professorship of Print Media Technology
Contents and qualification objectives	Contents: The course Printed Electronics gives an overview about the basics of the comparable young research field Printed Electronics – including typical materials, printed electronic devices, modules and systems. The course consists of the following main topics: technologies for the realization of structured and non-structured thin films and layers; materials used for printed electronics, e.g. functional polymers, small molecules, nano-materials for conductive, semi conductive, dielectric layers; device set-up, functionality and characterization (e.g. for organic field effect transistors, solar cells, batteries, super caps, sensors, loudspeakers). In the seminar Special Topics of Functional Printing, students have the opportunity to focus on special matters related to the lecture or current ongoing research in the field of printed electronics. They will give an own presentation to one special topic. Additional presentations will be given by internal and external researchers. Qualification objectives: Students will get deep knowledge about the systematics, the working principles and the applications of functional printing and printed electronics.
Teaching formats	The teaching format are lectures (V) and seminar (S). • V: Printed Electronics (2 LVS) • S: Special Topics of Functional Printing (2 LVS)
Preconditions for participation (recommended knowledge and skills)	Base module 1.1 to 1.4
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. • Module 1.1 Mathematics for Engineering Sciences And the following prerequisites for admission (can be repeated unlimited): • 15-minute oral certificate for the seminar lectures Special Topics of Functional Printing
Module examination	The module examination consists of: • 90-minute written examination on Printed Electronics & Special Topics of Functional Printing (Examination number: 31342).
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Printed Functionalities, supplementary module Elective Courses

Module number	3.2.4
Module name	Automotive Sensor Systems
Responsible for the module	Professorship of Electronic Components/Electrical Measurements and Sensor Technology
Contents and qualification objectives	Contents: • General aspects of the use of sensors in automobiles • Sensors for engine management • Sensors for the chassis • Sensors for active and passive safety (e.g. ABS, ESP) • Driver Assistance Systems • Sensors for air quality monitoring • Exhaust gas sensors • Sensors for acceleration, force, pressure, speed • Self-monitoring and self-calibration for robustness Qualification objectives: • Gain an overview of various principles and possibilities of realization of • Sensors for automotive applications • Methodology for targeted literature research • Lecture and presentation technique • Methodology and preparation of technical reports
Teaching formats	The teaching format are lectures (V) and seminar (S). • V: Automotive Sensor Systems (1 LVS) • S: Automotive Sensor Systems (3 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Successful completion of the module examination is a prerequisite for the award of credit points.
Module examination	The module examination consists of two examination papers. In detail, the following examination papers are to be completed: • 30-minute oral examination on Automotive Sensor Systems (examination number: 42003) • written elaboration (technical report) on Automotive Sensor Systems (scope: 10-15 pages, processing time: 1 week) (examination number: 42004) The exams are to be taken in English.
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations. Examination: • oral exam on Automotive Sensor Systems, weighting 1 • written elaboration (technical report) on Automotive Sensor Systems, weighting 1
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Printed Functionalities, supplementary module Elective Courses

Module number	3.2.5
Module name	Printing Presses
Responsible for the module	Professorship of Print Media Technology
Contents and qualification objectives	Contents: The module gives an overview of materials and machines in the area of printing processes. The lecture includes part I: Machines: Systematics and overview of the machine components and variants in the different process stages, design of the material flow of printing and printing material, web guiding, machine and process control, characteristic assemblies, precision, special features in production. Part II: Material properties: Mechanical properties of flexible and rigid substrates, substrate rheology, dynamic behavior in layer formation, material transport and drying. In the practical training, the content of the material is deepened in calculation examples and tasks for the configuration and design of machines and processes. Qualification objectives: Students will get deep knowledge about the systematics, function and application scenarios of the modern and current printing press devices. They should be empowered to penetrate the field of engineering science.
Teaching formats	The teaching format are lectures (V) and exercises (Ü). • V: Printing Presses (3 LVS) • Ü: Printing Presses (1 LVS)
Preconditions for participation (recommended knowledge and skills)	Base module 1.1 to 1.4
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. These requirements are: • Module 1.1 Mathematics for Engineering Sciences and the following prerequisites for admission (can be repeated unlimited): • Certificate (seven successful test protocols) in the exercise Printing Presses
Module examination	The module examination consists of: • 90-minute written examination on Printing Presses (examination number: 31344).
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Printed Functionalities, supplementary module Elective Courses

Module number	3.2.6
Module name	Media Physics
Responsible for the module	Professorship of Print Media Technology
Contents and qualification objectives	Contents: The course gives a deeper insight into the relationships between information and physical media in general. The lecture includes: structures and their production, characterization and properties, information and modulation, noise and roughness, coding, scales, complexity and emergence, definitions of information, entropy, order, etc. In the seminar, students work on current topics with the help of current scientific publications from the lecture area and present and discuss the results in seminar papers. Qualification objectives: The student should get a deep understanding of structures and information and thus be able to classify the new connection possibilities of the printed functionalities.
Teaching formats	The teaching format are lectures (V) and seminar (S) • V: Media Physics (2 LVS) • S: Media Physics (2 LVS)
Preconditions for participation (recommended knowledge and skills)	Basic modules 1.1 - 1.4
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. These requirements are: • Module 1.1 Mathematics for Engineering Sciences
Module examination	The module examination consists of an examination: • 30-minute oral exam on Media Physics (examination number: 31311)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Printed Functionalities, supplementary module Elective Courses

Module number	3.2.7
Module name	Research Lab
Responsible for the module	Professorship of Print Media Technology
Contents and qualification objectives	Contents: The class prepares for the research project and the master thesis. In the lab course, the students receive a research task, which has to be investigated independently in a small team of students under supervision. The students perform a literature research, experiments in the labs of the university, and present the results of their research in a report and a presentation. The individual contribution of each student has to be highlighted. In the lecture, background knowledge of the research topic, the laboratory equipment and the scientific work is given. Qualification objectives: The objective of the Research Lab is to teach the student to work scientifically in a team and to prepare for research topics and their master thesis.
Teaching formats	The teaching format are lectures and lab courses. • V: Research Lab (1 LVS) • P: Research Lab (3 LVS) The course schedule is planned individually. The student has to prove sufficient knowledge in preparative discussions.
Preconditions for participation (recommended knowledge and skills)	Base module 1.1 to 1.4, Profile module 3.2.1 to 3.2.3
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. • Module 1.1 Mathematics for Engineering Sciences
Module examination	The module examination consists of: • Report (15 pages per student, 15 week's time) and a final presentation (15 minutes per student) examination number: 31346
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Printed Functionalities, supplementary module Elective Courses

Module number	3.2.8
Module name	Advanced Surfaces, Thin Films and Interfaces
Responsible for the module	Professorship of Technical Physics
Contents and qualification objectives	Contents: • Vacuum Technology • Methods for film production • Fundamentals of crystallography in two dimensions, relaxation, reconstruction • Elementary processes on the surface (adsorption, desorption, diffusion) • Electronic surface states, image states • Surface analysis I: Diffraction methods • Surface analysis II: Electron spectroscopy • Surface Analysis III: Microscopy • Characterization of thin films with ions • Interfaces, Quantum Well States Qualification objectives: Introduction to modern surface physics, teaching the physical basics and concepts, interface effects, vacuum technology and analysis methods
Teaching formats	The teaching format are lecture, tutorial and seminar. • V: Surfaces, Thin Films and Interfaces (2 LVS) • T: Surfaces, Thin Films and Interfaces (1 LVS) • S: Advanced Surfaces, Thin Films and Interfaces (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. • Module 1.1 Mathematics for Engineering Sciences Preliminary examination (can be repeated indefinitely): • 30-minute presentation in the seminar Advanced Surfaces, Thin Films and Interfaces
Module examination	The module examination consists of: • 20-minute oral examination on the contents of the module (examination number: 11709
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.1
Module name	Resource Management: Challenges for Political Processes
Responsible for the module	Professorship International Relations
Contents and qualification objectives	Contents: The module provides knowledge about the political implication of resource availability and demand. On this basis, the challenges for the political processes of resource management will be analyzed. Qualification objectives: Understanding the interdependences between technical, economic and political processes and the resulting challenges in the security of energy resource supply and resource efficiency. In addition, an insight of political scopes of action and design options is conveyed.
Teaching formats	The module's type of course is the seminar. • S: Resource Management: Challenges for Political Processes (2 LVS)
Requirements for participation (recommended knowledge and skills)	None
Applicability of the module	---
Requirements for the award of credit points	Meeting the prerequisite for admission to the exam and successfully passing the module exam are the requirements for earning credit points. The prerequisite for admission is the following exam: • Module 1.1 Mathematics for Engineering Science and following pre-exam achievement (can be repeated an unlimited number of times): • 20-minute presentation with a two pages handout in the course
Module examination	The module examination consists of: • 60-minute written exam on Resource Management: Challenges for Political Processes (examination number: 77427). The examination can be taken in German or English.
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module will be offered in the winter semester of every academic year.
Workload	The module comprises a students' workload of 150 WH (working hours).
Duration of the module	In a regular course of studies, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.2
Module name	Life Cycle Engineering
Responsible for the module	Chair of Management Accounting and Control
Contents and qualification objectives	Contents: The module provides an overview of the basic ideas and the theoretical background of Life Cycle Engineering (LCE) as well as deeper insights in specific approaches and modeling techniques. Specific topics are (among others): • product life cycle models • evaluation of technical, economic and ecological performances • multi-dimensional performance models • material and technology selection • case studies Qualification objectives: This course contributes to recognizing the importance of including multiple objectives from the technical, the economic and the ecological dimension for decision making in early stages of product design. A special focus is given to appropriate approaches and models whose practical application is trained in the seminar.
Teaching formats	The teaching forms of the module are lecture and exercise. • V: Life Cycle Engineering (2 LVS) • Ü: Life Cycle Engineering (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Meeting the prerequisite for admission to the exam and successfully passing the module exam are the requirements for earning credit points. The prerequisite for admission is the following exam: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • 90-minute written exam on Life Cycle Engineering (examination number 61421)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.3
Module name	Life Cycle-oriented Management
Responsible for the module	Chair of Management Accounting and Control (with content participation of Chair of Business Taxation and Auditing)
Contents and qualification objectives	Contents: Firstly, the module provides an overview of life cycle models and concepts. Thereafter, strategic life cycle-related design tasks and deployable methods are presented. The discussion of life cycle-related decision models and methods is a key aspect of the module. This includes (among others): • Life Cycle Costing/Total Cost of Ownership • Dynamic investment appraisal supporting decisions about profitability, useful economic life and replacement timing • Approaches for including taxes • Material Flow Cost Accounting • Value Stream Design • Life Cycle Assessment Qualification objectives: Participants learn about life cycle-related decisions from an economic perspective and get specific knowledge about corresponding methods enabling an informed decision-making.
Teaching formats	The teaching forms of the module are lecture and exercise. • V: Life Cycle-oriented Management (2 LVS) • Ü: Life Cycle-oriented Management (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Meeting the prerequisite for admission to the exam and successfully passing the module exam are the requirements for earning credit points. The prerequisite for admission is the following exam: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: 90-minute written exam on Life Cycle-oriented Management (number 61420)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.4
Module name	Sustainability Management/Environmental Management Accounting
Responsible for the module	Dean of the Master degree program "Business Administration" of the Faculty of Economics and Business Administration
Contents and qualification objectives	Contents: The module provides a general introduction to the topic of sustainability. Afterwards, the role of sustainability management in the companies will be investigated and appropriate related tools and methods will be illustrated in details. Individual topics are i. a.: • Sustainability –necessity, concepts and models • Sustainability management and its anchoring in (exiting) operational management systems • Tools and methods of the sustainability management, in particular in the field of the Environmental Management Accounting Qualification objectives: The module aims to illustrate the need for a corporate sustainability management and, beyond that, to show how a sustainability management can be implemented.
Teaching formats	The module's types of courses are lecture and practical courses. • V: Sustainability Management/Environmental Management Accounting (2 LVS) • Ü: Sustainability Management/Environmental Management Accounting (1 LVS)
Requirements for participation (recommended knowledge and skills)	None
Applicability of the module	---
Requirements for the award of credit points	Meeting the prerequisite for admission to the exam and successfully passing the module exam are the requirements for earning credit points. The prerequisite for admission is the following exam: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • 90-minute written exam on Sustainability Management/Environmental Management Accounting (examination number: 62104)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module will be offered in the summer semester of every academic year.
Workload	The module comprises a students' workload of 150 WH (working hours).
Duration of the module	In a regular course of studies, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.5
Module name	IT-supported Evaluation of Material Flows and Process Chains
Responsible for the module	Chair of Management Accounting and Control
Contents and qualification objectives	Contents: Interdisciplinary case studies to be worked on in small groups, in which application and consolidation of the acquired knowledge regarding the evaluation of material flows and process chains takes place and the problem-related knowledge and skills as well as the use of suitable software tools are deepened independently. Qualification objectives: The focus is on the application or linking of theoretical knowledge from the core and profile modules upstream in the curriculum. In addition, the joint processing of the case study and presentation of the results promote the further development of social skills as well as the presentation, discussion and moderation skills of the participants.
Teaching formats	The teaching form of the module is the case study. • FS: Case study of IT-supported Evaluation of Material Flows and Process Chains (2 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. The admission requirements for the exam of oral presentation of the case study is: • Module 1.1 Mathematics for Engineering Sciences
Module examination	The module examination consists of two examinations. The following examinations are to be taken: • Written draft (length: 10-15 pages, processing time: 13 weeks) (exam number: 61422) • 15-minute oral presentation of the case study (examination number: 61423)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations. Examinations: • Written preparation, weighting 3 – pass required • Oral presentation, weighting 2 – pass required
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150.AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.6
Module name	Innovation and Value Creation
Responsible for the module	Chair of Ergonomics and Innovation Management
Contents and qualification objectives	Contents: New possibilities of the Internet, social networks and the omnipresence of computers (pervasive computing) are changing innovation processes and value chains. Considering this, the course introduces the concept of interactive value creation and related approaches. Students have the opportunity to reflect and discuss the effects on the strategic and operational management of technology-oriented companies and on the work organization of the future. Focuses are on • Innovation management processes • Collaborative innovation • Interactive added value • Open innovation Qualification objectives: Students gain knowledge on current concepts of technology-oriented innovation management and they can classify trends. They are empowered to deal independently with the fundamentals of innovation management and to acquire applicable methodological skills by practicing selected methods.
Teaching formats	The seminar is the teaching form of the module. • S: Innovation and Value Creation (2 LVS (course hours))
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	The fulfillment of the admission requirements for the individual examinations and the successful completion of the module examination are preconditions for the award of credit points. Admission requirements for the examination seminar paper are: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of two examinations. The following examinations are to be taken: Eligible course achievements: • Five recorded practical achievements (size: 1-4 pages each, scheduled time: 1 week each) for Innovation and Value Creation (exam number: 31219) • Seminar paper (size: 12-15 pages, scheduled time: 8 weeks) on Innovation and Value Creation (exam number: 31220) The course achievement is credited if the grade of the course achievement is at least “sufficient”.
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the marking are regulated in § 10 of the Examination Regulations. Eligible course achievements: • recorded practical achievements for innovation and value creation, weighting 1 • Seminar work on innovation and value creation, weighting 2

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.7
Module name	Digital Ergonomics
Responsible for the module	Chair of Ergonomics and Innovation Management
Contents and qualification objectives	Contents: In order to make work productive, healthy, motivating and beneficial, it is necessary to adapt working conditions to the physiological, psychological and cognitive requirements and abilities of man. The course introduces self-learning material on ergonomic analysis and on ergonomic work design concepts. On this basis, the course imparts expertise and methodological skills in seminars and tutorials in order to apply the ergonomic concepts with the help of advanced digital tools. Focuses are on • basic concepts of ergonomic work analysis and work design • selected methods of ergonomic work analysis and work design (e.g. in the areas of anthropometry, physical strength, posture, target times) • 3D modeling of work systems • Modeling with digital human models • Ergonomic analyzes with digital human models • Deriving ergonomic improvement measures using a case study Qualification objectives: Students can apply the principles and rules of ergonomic analysis and design of work with the help of selected digital tools. They can reflect on the potential and limits of digital ergonomics.
Teaching formats	The seminar and the tutorial are the teaching forms of the module. • S: Digital Ergonomics (2 LVS (course hours)) • Ü: Digital Ergonomics (2 LVS (course hours))
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	The fulfillment of the admission requirements for the individual examinations and the successful completion of the module examination are preconditions for the award of credit points. • Admission requirements for the examination seminar paper are: Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of two examinations. The following examinations are to be taken: Eligible course achievements: • Five recorded practical achievements (size: 2-4 pages each, scheduled time: 1 week each) for Digital Ergonomics (exam number: 31221) • Home work (size: 10-15 pages, scheduled time: 8 weeks) on Digital Ergonomics (exam number: 31222) The course achievement is credited if the grade of the course achievement is at least “sufficient”.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the marking are regulated in § 10 of the Examination Regulations. Eligible course achievements: • recorded practical achievements for innovation and value creation, weighting 1 • home work on digital ergonomics, weighting 1
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Work Design and Sustainability Management, supplementary module Elective Courses

Module number	3.3.8
Module name	Instrumentation
Responsible for the module	Professorship Sports Equipment and Technology
Contents and qualification objectives	Contents: The course Instrumentation conveys the procedure and the special requirements to measure the human-environment interaction with measuring instruments. The basic approach for the selection of suitable hardware, software and measurement methodology as well as the design and composition of corresponding measurement chains is taught regarding different measuring tasks. Qualification objectives: After successful attendance of the course, the students gain a deeper understanding in the basic principles for the selection of sensors and data acquisition systems to measure physical and mechanical human motion parameters. They are enabled to use creatively and independently the relevant evaluation methods and corresponding software. In addition, they learn the special requirements for designing a measurement chain and apply them to solve an individual measuring task.
Teaching formats	The module's types of courses are lecture and practical course. • V: Instrumentation (1 LVS) • P: Instrumentation (2 LVS)
Requirements for participation (recommended knowledge and skills)	None
Applicability of the module	---
Requirements for the award of credit points	Meeting the prerequisite for admission to the exam and successfully passing the module exam are the requirements for earning credit points. The prerequisite for admission is the following exam: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • elaboration of a scientific poster (size: A0, processing time 4 weeks) with 30-minute defense (5-minute presentation and 25-minute discussion) on instrumentation (examination number: 32817)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module will be offered in the winter semester of every other academic year.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends over one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Production Systems, supplementary module Elective Courses

Module number	3.4.1
Module name	Joining Technologies and Strategies
Responsible for the module	Professorship Welding Technology
Contents and qualification objectives	Contents: The module teaches the basics of industrially used joining techniques and their application possibilities. It deals with force-, shape- and material- locking joining technologies, material-technical aspects of joining processes as well as possibilities for the characterization of joining properties Qualification objectives: Students will be able to select joining techniques for various application scenarios, considering technological, material-technical and design aspects.
Teaching formats	Lectures and exercises are the teaching forms of the module. • L (Lecture): Joining Technologies and Strategies (2 LVS) • E (Exercise): Joining Technologies and Strategies (1 LVS)
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	The fulfilment of the admission requirements for the examination performance and the successful completion of the module examination are requirements for the award of credit points. The prerequisite for admission is: • Module 1.1 Mathematics for Engineering Science and subsequent preliminary examination (unlimited repeatability): • passed exercise in the exercise Joining Technologies and Strategies. Passed means, that at least 50 % of the evaluation points were achieved.
Module examination	The module examination consists of an examination performance: • 90-minute exam on Joining Technologies and Strategies (examination number: 32715)
Credit points and marks	5 credit points are earned in the module. The assessment of the examination performance and the formation of the module grade are regulated in § 10 of the examination regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a total workload of 150 AS for the students.
Duration of the module	If the course of studies is regular, the module lasts one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Production Systems, supplementary module Elective Courses

Module number	3.4.3
Module name	Machining Technologies
Responsible for the module	Professorship Production Systems and Processes
Contents and qualification objectives	Contents: Advanced knowledge of machining is imparted. Building on the process fundamentals, special attention is paid to the design of efficient processes. Here the focus is on the target-oriented selection of the decisive system variables and the determination of the process setting variables. The tool selection and the specific determination of the cutting parameters are the focal points. The methods of CNC machining are taught on the basis of process examples in an application-oriented manner. The aim is the independent process design of turning, milling and water jet processes including implementation. Finally, the trends in machining are discussed. Qualification objectives: After completion of the module the students are able to, • select machining procedures for geometric forms, • select system variables such as tools and clamping devices in relation to the work-piece properties, • determine process parameters in a targeting manner, • create NC machining programs themselves with different methods, • optimize milling processes in terms of cost and quality criteria, • assess the current trends in machining.
Teaching formats	Forms of teaching within the module are Lectures, Exercises and Practical Courses • V: Machining Technologies (1 LVS) • Ü: Machining Technologies (1 LVS) • P: Machining Technologies (2 LVS)
Preconditions for participation (recommended knowledge and skills)	Basic knowledge of manufacturing technologies.
Applicability of the module	---
Preconditions for the award of credit points	The fulfilment of the admission requirements for the examination performance and the successful completion of the module examination are requirements for the award of credit points. The prerequisite for admission is: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • 120-minute written examination on Machining Technologies (examination number: 33641)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the winter semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile area Production Systems, supplementary module Elective Courses

Modul number	3.4.4
Modul name	Efficient Process Chains
Responsible for the module	Professorship Micromanufacturing Technology
Contents and qualification objectives	Contents: The module conveys fundamentals and approaches in the development of resource efficient processes and process chains. Firstly, there is a survey on methods for the structuring of manufacturing processes as well as technology and manufacturing planning. Subsequently fundamentals on cutting, abrasive and forming processes with examples from threading, hard and non-circular turning, deep hole drilling, dry machining, deburring and others are given. These manufacturing processes are then analyzed and compared regarding their efficiency in the context of the whole process chain. Furthermore, the process chains and operating materials for the manufacturing of rotationally symmetric and prismatic workpiece especially in mechanical engineering and automotive are explained and detailed based on specific examples. Qualification objectives: Subsequent to the successful attendance of the module, the students are capable of … • explaining the necessity of efficiency improvement in process chains. • explaining the fundamental structure of process chains from raw stock to workpiece in manufacturing rotationally symmetric and prismatic workpieces by means of workflow charts. • analyzing existing process chains, identifying optimization potential and develop possible solutions for increased efficiency.
Teaching formats	Form of teaching of the module are lectures, exercises and practical training. • L: Efficient Process Chains (2 LVS) • E: Efficient Process Chains (1 LVS) • P: Efficient Process Chains (1 LVS)
Preconditions for participation (recommended knowledge and skills)	Fundamental knowledge concerning manufacturing processes and technologies.
Applicability of the module	---
Preconditions for the award of credit points	The fulfilment of the access requirements for the test achievement and the successful passing of the module exam are prerequisites for the awarding of credit points. Access requirements are: • Module 1.1 Mathematics for Engineering Science
Module examination	The module exam consists of one test achievement. • 120-minute written exam on efficient process chains (examination number: 32419)
Credit points and marks	In the module 5 credit points can be achieved. The evaluation of the exam performance and the valuation of the module grade are regulated according to § 10 of the examination regulations.
Frequency	The module is provided in each study year in winter semester.
Workload	The module comprises a total work load of 150 AS.
Duration of the module	In case of regular study progress the duration of the module is one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile line Production Systems, supplement module Elective Courses

Module number	3.4.5.
Module name	Geometrical Product Specification and Verification
Responsible for the module	Professur Fertigungsmesstechnik
Contents and qualification objectives	Contents: Geometrical specification is the basis for the development of products, correct simulation analysis, manufacturing, measurement and more. The module presents an overview of the concept of the international Geometrical Product Specification and Verification (GPS) system. The nonverbal communication method introduces symbols and rules to describe geometrical properties complete and unambiguous. Verification methods are presented for measuring deviations on real parts to collect data in cor- relation to functional and process parameters. Decision rules provide the students with knowledge on the selection of the measuring methods and strategies. Exercises and practical trainings are added to learn how to use the GPS system for the specification, work with measurement instruments and correlate measurement results with the specification. Qualification objectives: At the end of the module, the students understand the basic concepts of the GPS-system. Theoretical and practical knowledge is available for solving fundamental specification and verification tasks. They are especially qualified to specify geometrical properties according to functional properties as basis for the derivation of manufacturing technolo- gies. Besides that, they can select measurement instruments for different geometrical measurements and understand measurement results to correlate with specification.
Teaching formats	The module consists of lecture, exercises and practical training • L: Geometrical Product Specification and Verification (2 LVS) • E: Geometrical Product Specification and Verification (1LVS) • P: Geometrical Product Specification and Verification (1 LVS)
Preconditions for participation (re- commended know- ledge and skills)	Basic knowledge in design and manufacturing technologies.
Applicability of the module	--
Preconditions for the award of credit points	The fulfillment of the admission requirements for the examination and the successful completion of the module examination are prerequisites for the award of credit points. Admission requirements: • Module 1.1 Mathematics for Engineering Science and the following prerequisite (unlimited repeatable): • successful certified practical training in Geometrical Product Specification and Verification
Module examination	The module examination consists of 30-minute oral exam on the topic of Geometrical Product Specification and Verification (examination number: 31719)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Profile module profile line Production Systems, supplement module Elective Courses

Module number	3.4.6
Module name	Design and Control of Smart Production Systems
Responsible for the module	Professorship Production Systems and Processes Professorship for Adaptronics and Lightweight Design (in Production)
Contents and qualification objectives	Contents: The fundamentals, procedures and methods for the development, monitoring and control of modern mechatronic production systems are taught. Based on a detailed description, modeling and simulation of central components, tools for the evaluation and development of production systems are addressed. The acquisition of information, its conversion, forwarding and processing in the context of the Internet of Things is dealt with in depth. Furthermore, the expansion of process boundaries through the integration of actuator and sensor functionality close to the point of action is dealt with. Automation, as an essential link, complements the course with the aspects of planning, control and monitoring of movements in production systems. This includes an overview of systematic design methods as well as the structure, mode of operation, programming and operation of current control systems. Qualification objectives: • to recognize and evaluate interdisciplinary relationships in the mechatronic system of machine tools, • to describe individual components of machine tools and multi-machine systems, • to implement the possibility of data acquisition and analysis according to the situation, • apply experimental and simulative methods to identify mechanical and control parameters, and • design the control system for typical drive solutions in mechanical engineering.
Teaching formats	Forms of teaching within the module are Lectures, Exercises and Practical Courses • V: Design and Control of Smart Production Systems (2 LVS) • Ü: Design and Control of Smart Production Systems (1 LVS) • P: Design and Control of Smart Production Systems (1 LVS)
Preconditions for participation (recommended knowledge and skills)	Basic knowledge of mechanics, machine elements, electrical engineering
Applicability of the module	---
Preconditions for the award of credit points	Successful completion of the module examination is a prerequisite for the award of credit points. Precondition is: • Module 1.1 Mathematics for Engineering Science
Module examination	The module examination consists of: • 120-minute written examination on Design and Control of Smart Production Systems (examination number: 33642)
Credit points and marks	5 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations.
Frequency	The module is offered every academic year in the summer semester.
Workload	The module comprises a students' workload of 150 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Research module

Module number	5
Module name	Research Project/Internship
Responsible for the module	Dean of Studies Advanced Manufacturing at the Faculty of Mechanical Engineering
Contents and qualification objectives	Contents: The research project deals with the independent and systematic processing of a research-oriented task in the area of advanced manufacturing using the knowledge acquired so far. The task should be carried out in a team and supervised by a professor involved in the course. Processing can take place (a) in a test field or laboratory located at the professorship or (b) externally as an industrial internship in a research-related area. In addition to the technical questions of the respective task, the students should also be introduced to methodological and practical problems and their solution in the area of research. Qualification objectives: By working on the research project, the students should be made aware of the importance of methods for organization and problem solving in research-oriented groups. Demands are placed on the ability to analyze and solve problems as well as time and project management
Teaching formats	Teaching forms of the module are internship and project. From following offers an offer must be selected. Offer 1: • P: Internship (15 weeks during the semester, externally in the company) Consultations can be held with the supervisor for support. Offer 2: • RP: Research project (15 weeks during the semester) (2 LVS) Consultations can be held with the supervisor for support.
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	Meeting the course prerequisites is a requirement to take the module examinations to obtain credit points. These requirements are: • Module 1.1 Mathematics for Engineering Sciences
Module examination	The module examination consists of two exams. Depending on the choice of offer, the following examinations must be taken: Offer 1: • Internship report (approx. 15 pages, processing time: 15 weeks) (examination number: 8110) • 30-minute oral exam, consisting of a 15-minute lecture followed by a discussion (examination number: 8120) • Offer 2: • Project work (approx. 15 pages per student, processing time: 15 weeks) (examination number: 8130) • 30-minute oral exam, consisting of a 15-minute lecture followed by a discussion (examination number: 8140)

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Credit points and marks	10 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations. Examinations: Offer 1: • Internship report, weighting 7 - pass required • Oral exam, weighting 3 - pass required Offer 2: • Project work, weighting 7 - pass required • Oral exam, weighting 3 - pass required
Frequency	The module is offered every academic year in the summer and winter semester.
Workload	The module comprises a students' workload of 300 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.

Annex 2: Module description for the English-language consecutive study program Advanced Manufacturing with the degree Master of Science

Module Master Thesis

Module number	6
Module name	Master Project with colloquium
Responsible for the module	Dean of Studies Advanced Manufacturing at the Faculty of Mechanical Engineering
Contents and qualification objectives	Contents: As part of this module, the master's thesis is created and presented and defended in a colloquium. The solutions are to be coordinated with the scientific supervisor. Qualification objectives: The student is able to work independently on a multidisciplinary scientific and technical task using scientific methods within a specified period.
Teaching formats	After an introduction to the tasks and objectives of the topic, the module has to be worked on independently and scientifically. For support consultations with the supervisor of the master thesis have to be arranged.
Preconditions for participation (recommended knowledge and skills)	None
Applicability of the module	---
Preconditions for the award of credit points	The fulfillment of the admission requirements for the individual examinations and the successful completion of the module examination are prerequisites for the award of credit points. Admission requirements are: • for the master's thesis: Modules in the amount of 85 LP • for the examination performance oral examination (lecture and colloquium on the results of the master thesis): Modules amounting to 90 CP and the master's thesis is rated at least “sufficient”.
Module examination	The module examination consists of two exams. The following examinations are to be taken: • Master's thesis (approx. 80 pages, processing time: 23 weeks) (examination number: 9110) • 45-minute oral exam (lecture and colloquium on the results of the master's thesis) (examination number: 9120)
Credit points and marks	30 credit points are awarded within the module. The grading of the examination and the generation of the mark is regulated in § 10 of the Examination Regulations. Examinations: • Master's thesis, weighting 7 - pass required • Oral examination (lecture and colloquium on the results of the master's thesis), weighting 3 - pass required
Frequency	The module is offered every academic year in summer and winter semester.
Workload	The module comprises a student’s workload of 900 AS (working hours).
Duration of the module	In a regular course of studies, the module extends to one semester.