Modules of the degree program

Sustainable Engineering of Products and Processes (Bachelor)

PO 1

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Bachelor Sustainable Engineering of Products and Processes	
ECTS	180

Compulsory Modules: Fundamentals of Mathematical Science and Information Technology	
ECTS	31

Title	Digital Tools
Number	2515300
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written examination+, 135 minutes
Course achievement	2 optional course achivements: a) Creation and documentation of computer programmes in the winter semester. (on application, the result of the course achievement is taken into account in the assessment of the written examination+. The course achievement can account for up to 10 % of the grade of the written examination+.) b) Creation and documentation of computer programmes in the summer semester (on application, the result of the course achievement is taken into account in the assessment of the written examination+. The course achievement can account for up to 10 % of the grade of the written examination+.). In the case of a) and b), the application must be submitted to the examiner before the start of the written examination+.
Module grade composition	
Objective qualification	
After completing the module, students are able to use object-oriented programming languages (Python, C ++) and their environment (development environments, expansion modules) in a goal-oriented manner. The skills learned include working effectively with vectors, matrices and their algebra, visualizing and analyzing data, performing simple simulations and working with symbolic mathematics. The students are able to combine and link efficiently and problem-oriented the various digital tools. Furthermore, the students are able to perform object-oriented software engineering for new problems and to design algorithms on the basis of design patterns and to develop and use corresponding data structures. The students also have initial theoretical and practical knowledge in the areas of optimization and machine learning.	

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Title	Fascination Mechanical Engineering
Number	2516510
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam+, 90 minutes
Course achievement	course achievement: Term paper in the form of a video presentation on the project accompanying the lecture (on application, the result of the course achievement is taken into account in the assessment of the written examination+. The course achievement can account for up to 20% of the grade of the written examination+)
Module grade composition	
Objective qualification	

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Title	Mathematics for Engineers A
Number	1294250
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	Graded examination (Prüfungsleistung): 1 written exam (180 minutes) according to examiner's specifications. The exact examination specifications will be announced at the beginning of the course.
Course achievement	
Module grade composition	

Objective qualification

The students combine the learnt mathematical methods of univariate calculus and linear algebra in the description and investigation of applied problems in the engineering
sciences. They choose appropriate calculation techniques and appropriate methods of proof for the discussion of the mathematical fundamentals in the applied and engineering sciences,
and they apply these techniques and methods. The students explain the formation of mathematical concepts and they derive the motivation of these concepts from applications and from the mathematical specification and delimitation of terms and definitions. The students reproduce and explain basic proofs and ideas of proofs in univariate calculus and linear algebra. They are able to identify and to test relations between the learnt concepts. The students are able to analyse mathematical problems occurring in applications and engineering lectures,
to extract and to solve treatable sub-problems and to identify continuative difficulties. Finally, students use constructively modern tools for the treatment of computational problems.

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Title	Mathematics for Engineers A
Number	1294250
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	1 written exam (180 minutes) After approval by the examination board mathematics (Prüfungsausschuss Mathematik), the examiner can also choose the take-home exam as the form of examination.
Course achievement	
Module grade composition	

Objective qualification

The students combine the learnt mathematical methods of univariate calculus and linear algebra in the description and investigation of applied problems in the engineering
sciences. They choose appropriate calculation techniques and appropriate methods of proof for the discussion of the mathematical fundamentals in the applied and engineering sciences,
and they apply these techniques and methods. The students explain the formation of mathematical concepts and they derive the motivation of these concepts from applications and from the mathematical specification and delimitation of terms and definitions. The students reproduce and explain basic proofs and ideas of proofs in univariate calculus and linear algebra. They are able to identify and to test relations between the learnt concepts. The students are able to analyse mathematical problems occurring in applications and engineering lectures,
to extract and to solve treatable sub-problems and to identify continuative difficulties. Finally, students use constructively modern tools for the treatment of computational problems.

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Title	Mathematics for Engineers B
Number	1294260
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	

Objective qualification

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Title	Mathematics for Engineers B
Number	1294260
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	1 written exam (180 min) After approval by the examination board mathematics (Prüfungsausschuss Mathematik), the examiner can also choose the take-home exam as the form of examination.
Course achievement	
Module grade composition	

Objective qualification

The students combine the learnt mathematical methods of multivariate calculus and differential equations in the description and investigation of applied problems in the engineering sciences. They use constructively the mathematical formalism of scalar and vector fields, of differential operators, of different integral concepts and of Fourier analysis to model and analyse mechanical applications. The students describe time-dependent processes by means of ordinary differential equations and explain the close relation to dynamics and to oscillations. They analyse the quantitative and qualitative behaviour of ordinary differential equations and explicate the basic existence and uniqueness theorems. The students model fundamental applications, derive the behaviour of the trajectories and calculate solutions of systems of differential equations manually as well as by use of modern computational tools. The students combine their competences in technical mechanics with those in mathematics and they transfer their detailed insight of the one-mass oscillator to more general oscillating systems and their motion. They identify the system response and transient parts of the oscillations, and they explain resonance phenomena.

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Title	Control Theory
Number	2599460
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 120 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students know the basic structures, terms and methods of control engineering and can apply them to all simple technical or physical systems. With Laplace transformation, transfer function, frequency response, stability criteria, state space concept and the description of mathematical systems, students learn how to set up equations for unknown dynamic systems. Furthermore, control loop elements, the analysis of linear systems in the time and frequency domain as well as controller design for unknown systems can be applied. By means of theoretical and illustrative examples, the students can abstract and deal with control engineering problems from various disciplines. The control engineering methods and requirements are placed in the context of the design of production processes, process optimization and process control and can be transferred by the students to corresponding unknown systems.	

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Compulsory Modules: Fundamentals of Engineering	
ECTS	23

Title	Fundamentals of Fluid Mechanics
Number	2512190
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam of 150 minutes or oral exam of 45 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students can delineate the characteristics of continuum analysis in fluids. The students can state and explain the axioms of moving fluids. They can derive useful simplifications of the equations of motion of fluids and explain the corresponding physical content. The students are able to relate application oriented problems of fluid mechanics to analytical or empirical mathematical models and to solve the associated mathematical relations.	

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Title	Engineering Mechanics 1
Number	2544040
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Engineering Mechanics 2
Number	2540460
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students can name the basic concepts and can apply methods of kinematics and kinetics. They can model simple dynamic components and systems, formulate the associated equations of motion and solve them if necessary. Students are able to use an energy and working principle to analyse specific solutions. Students should independently formulate, solve and evaluate mechanical problems in engineering problems.	

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Title	Thermodynamics 1
Number	2519180
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students are able to name the basic terms and laws of thermodynamics and to list their most important consequences for energy conversion processes. The students can explain relevant characteristic numbers of technical systems on the bases of thermodynamic fundamentals. The students are able to apply scientific statements and processes in the field of thermodynamics to specific and practical problems. Students can analyze technical systems using balance equations of energy, mass, momentum and entropy. The students decide which of two processes is better suited to solve a problem of thermodynamics.	

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Compulsory Modules: Engineering Applications	
ECTS	14

Title	Fundamentals of Engineering Design
Number	2516520
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Materials Science
Number	2524370
ECTS	6,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 120 minutes
Course achievement	
Module grade composition	

Objective qualification

Students understand the relationship between material structure and material properties as well as the strengthening mechanisms in metals. This enables them to select and use metals, ceramics and polymers for applications in mechanical engineering in a meaningful way. For simple load cases they can calculate stresses, elastic strains and changes in shape. They are able to analyze stress-strain diagrams and determine material properties based on these diagrams. They can read phase diagrams. They are able to classify steels based on their designation. They comprehend the background of motion for vacancies and atoms at elevated temperatures. They understand essential mechanisms of oxidation and corrosion and can evaluate simple oxidation and corrosion processes on this basis. They learn how to assess materials and the design of components by using different test methods. The course treats important methods of processing of metals, ceramics, polymers and fibre reinforced composites, as well as the influence of these processes on properties of components. The students learn different application cases on basis of various examples. The students are able to basically explain the capacity to withstand stresses of materials with regard to different test methods. They can describe the most important principles of the processing of metals, polymers and fiber reinforced composites. Furthermore, they are able to discuss the influence of the processes on the properties of the component part with regard to the process chain. Moreover, they can outline the scope of application with descriptive examples.

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Compulsory Modules: Sustainability	
ECTS	17

Title	Energy Systems
Number	2520500
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	1 examination element: written exam, 120 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students know components and systems for the supply of electrical and thermal energy. They are able to explain the fundamentals of different conventional and renewable energy systems. They can calculate energy balances and electrical and themal efficiencies. The students can design simple energy systems on their own and can select suitable energy system architectures for specific problems.	

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Title	Environmental and Social Sustainability in Engineering
Number	2513350
ECTS	6,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Environmental and Social Sustainability in Engineering
Number	2513350
ECTS	6,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	1 Examination element: Written examination+, 120 minutes, or oral examination, 30 minutes
Course achievement	1 Course achievement: Report on the lecture-accompanying team project and presentation (On application, the result of the course achievement is taken into account in the assessment of the written examination+. The course achievement can account for up to a maximum 10 % of the grade of the written examination+.)
Module grade composition	
Objective qualification	

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Title	Sustainable Business Economics
Number	2542010
ECTS	6,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Specialisation: Sustainable Mobility

Specialisation Sustainable Mobility - Compulsory Modules	
ECTS	43

Title	Aircraft Design
Number	2515320
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Collaborative Work Sustainable Mobility
Number	2598130
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Aeroplane Performance
Number	2514580
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 120 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students will acquire knowledge about the fundamental mathematical and physical laws which are required for investigations of the flight performance of aircraft under different flight conditions. They will learn to evaluate different types of aircraft based on their performance. They will receive an insight into different factors influencing the flight performance.	

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Title	Fundamentals of Sustainable Product Development and Engineering Design
Number	2516500
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Fundamentals of Drive Systems
Number	2517290
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Multimodal Transport Systems
Number	2539450
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Numerical Methods for Mobility Applications
Number	2512390
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Vehicle Design
Number	2534380
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Specialisation Sustainable Mobility - Elective Modules	
ECTS	20

Title	Basics of Aircraft Propulsion
Number	2539460
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Introduction to Metrology
Number	2511160
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Basic Concepts of Lightweight Structural Design
Number	2515180
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students gain an overview of issues, phenomena, modeling and concepts of lightweight design. They are thus able to apply lightweight materials (mainly fiber composites) and their modeling, stability calculation methods, damage tolerance calculations with the necessary caution.	

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Title	Basics of Automotive Engineering
Number	2534250
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students are capable to analyse independently the longitudinal, lateral and vertical dynamic vehicle behavior in various driving situations. With the help of different calculation approaches they are able to analyse and evaluate the vehicle behavior. The students can recall automotive engineering terms and can explain their peculiarities. They are capable of classifying and analyzing the influences of typical vehicle parameters in a comprehensive survey of the vehicle's dynamic behavior. The students can interpret the basics of computer-aided modelling of the dynamic behavior of motor vehicles and can implement the methodical knowledge to optimize complex products. Based on various vehicle models they are able to check and argument independently when to use which model for each complex problem. Due to this, the students can communicate in technical discussions with specialists from the automotive sector and independently evaluate statements based on their learned knowledge in the area of longitudinal, lateral and vertical dynamic vehicle behavior.	

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Title	Fundamentals of Flight Guidance
Number	2513240
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Intelligent and Connected Vehicles
Number	2534390
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Air Traffic Simulation - Fundamentals of Flight Guidance
Number	2513250
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	Written exam, 90 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students learn the basics of simulation technology in the field of air traffic control. They understand the motivation of air traffic and workplace simulation and can describe the application in teaching, research and development operations. They can describe procedural models for the validation and verification of simulation systems and procedures in their structure and classify and explain them on the basis of examples. The students are able to apply the process steps of a model for a given simulation scenario and to interpret and compare the resulting development process.	

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Title	Mechanical Behaviour of Materials
Number	2524310
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
Through lectures, exercises and self-study, the students have in-depth knowledge of the mechanical behavior of all materials groups and the underlying deformation mechanisms. They understand the mechanical behaviour under multiaxial elastic and plastic loading, in the presence of notches and cracks as well as under cyclic and high temperature loading. They know the tools to calculate the material behavior under these loading conditions. As a result, they have acquired the ability to confidently use materials under mechanical load and to solve complex problems related to the mechanical behavior of materials.	

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Title	Mobile Machines and Commercial Vehicles
Number	2517180
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes, or oral exam, 30 minutes
Course achievement	
Module grade composition	

Objective qualification

After successful completion of this module, students are able to:
• describe different technical designs and typical areas of application of mobile machines, commercial vehicles, buses and industrial trucks.
• categorize the variety of mobile machines at a glance and assign the application areas of the machines.
• calculate, compare and evaluate machine concepts and components through comprehensive knowledge in the areas of structure, process technology, powertrain technology, chassis and wheel-to-ground interaction.
• decide which mobile machine including equipment is suitable based on the requirements and the work task.
• name the basic requirements of the Machinery Directive, its national implementation and the use of harmonized standards in the development of mobile machinery.

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Title	Modelling of Mechatronic Systems
Number	2540310
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	Written exam, 90 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students are able to apply a uniform approach to mathematically description of the dynamics of mechanical (multi-body) systems, electrical networks and mechatronic (electromechanical) systems. The use of different types of constraints can also be analysed and evaluated with regard to their solution behaviour. They can formulate and analyze equations of motion of selected mechatronic systems. They are thus able to independently develop and evaluate problem-adapted models for mechatronic problems.	

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Title	Sustainable Space Engineering
Number	2514690
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Railway Vehicles
Number	2539120
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Engineering Mechanics 3
Number	2543040
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students are capable of … 1. … naming important types of partial differential equations. 2. … associating important partial differential equations with exemplary engineering problems based on their mathematical behaviour. 3. … choosing appropriate solution methods for various math problems within the scope of partial differential equations. 4. … applying these solution methods on short exemplary math problems. 5. … assessing analytic solutions of exemplary problems according to the definition of models presented in this module.	

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Title	Thermodynamics 2
Number	2519190
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students are able to name the different forms and basic laws of thermodynamics and heat transfer. The students can discuss problems of thermodynamics and heat transfer using dimensionless characteristic numbers. The students are able to apply methods of thermodynamics and heat transfer to specific and practical problems. Students can analyze technically relevant problems of thermodynamics and heat transfer with help of the learned methods. The students are able to evaluate which of two processes is better suited to solve a problem of thermodynamics and heat transfer.	

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Title	Internal Combustion Engines and Fuel Cells
Number	2536200
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Traffic Control Engineering
Number	2539400
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam (120 minutes)
Course achievement	written report on practical exercices
Module grade composition	

Objective qualification

Students are able to analyse the functions, structures and technologies of traffic control systems as well as the physical, technological and operational fundamentals of land vehicles and infrastructure and to evaluate these using technical examples from the operations of road and railway transport. In doing so, they apply the technical terminology and the basics of transport technology as well as specific definitions and model concepts of road and rail transport and use them when working on technical examples. Students have the capacity of transferring what they have learned to the practical and operational conditions as they are presented in practical exercises at vehicle manufacturers and infrastructure facilities as well as operators of road and rail transport. They are able to explain traffic control concepts related to those practical examples. Students analyse the technical possibilities of influencing individual vehicle movement, traffic flows and traffic streams in mono- and multimodal networks and derive suitable solutions on the basis of case studies. Building on that, they discuss dynamic model concepts based on microscopic physical models up to aggregated flow models using practical examples and are able to apply those methods, means of description and tools to reproduce and analyse behaviour patterns with the aid of simulation models.

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Specialisation: Sustainable Energy and Process Engineering

Specialisation Sustainable Energy and Process Engineering - Compulsory Modules	
ECTS	48

Title	Plant Engineering and Construction (ME)
Number	2521340
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam (120 minutes) or oral exam (30 minutes)
Course achievement	
Module grade composition	
Objective qualification	
After completion of the module, students are able to plan plants, to illustrate them in flowcharts and layout plans and to design machines and apparatuses mathematically. They are able to explain the processes involved in the construction of a plant and are able to avoid common problems.	

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Title	Chemistry for Process Engineering and Materials Science
Number	2521570
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Collaborative Work Sustainable Energy and Process Engineering
Number	2598160
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	2 examination elements (project work): a) Preparation of the results in written form (to be weighted 5/6 in the calculation of the overall mark) b) Presentation of the project work (to be weighted 1/6 in the calculation of the overall mark)
Course achievement	1 course achievement (laboratory): colloquium and/or protocoll according to examiner's specifications
Module grade composition	
Objective qualification	
The students are able to work self-employed on a scientific topic and to handle the resulting tasks in teams based on the division of labor. They are qualified to research the relevant state of knowledge and technology for the question they have developed, to adopt the results of others, to compare them with each other and to present them. After successful completion of this course, students are able to carry out experiments either independently or under supervision, depending on the experimental set-up, to record measurement data and to evaluate these within the framework of scientific work with a concluding discussion of the experiments. They apply knowledge acquired in the lecture and the exercise in the practical lab.	

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Title	Introduction into Numerical Methods
Number	2520330
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	Written exam, 120 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students are able to select numerical methods for solving engineering problems in a goal-oriented manner based on the imparted methodological knowledge and to solve them on the computer using a proprietary programming language. They can evaluate simulation results in terms of numerical artifacts using error calculation rules. In the accompanying exercises, the students apply the practical handling of current numerical methods. The students discover the possibilities with and limitations of numerical methods on the basis of calculation examples and thereby acquire the ability to evaluate the results of numerical simulations on their practical significance.	

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Title	Basics of Solids Process Engineering (ME)
Number	2521360
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
After completion of this module, students are able to name and describe disperse properties of particles, forces and motion of particles in fluids, interactions between particles and flows of fluids through particulate packings, to derive important mathematical relationships and to graphically illustrate these relationships. Furthermore, the students are able to describe particle size analysis as well as the basic operations of mechanical process engineering separation, mixing, comminution and agglomeration by applying the above described fundamentals and to calculate example processes. Furthermore, students are able to sketch and describe selected facilities of the basic operations.	

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Title	Fundamentals of Sustainable Processes in Energy and Process Engineering
Number	2541470
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Unit Operations in Fluid Separations
Number	2541350
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
For a given separation task, students can identify which pure component and phase equilibrium data is needed for the selection and design of a suitable separation process. For the practical realization students are able to select a feasible process concept and execute the necessary calculations. They can describe alternative designs and their advantages and disadvantages. They can select and plan the dimensions of corresponding equipment according to operational and economical aspects. The students are able to execute experiments at laboratory scale (vapor-liquid-equilibrium, adsorption, rectification and crystallization) individually or in small groups. Further they can discuss and interpret the corresponding results.	

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Title	Thermodynamics 2
Number	2519190
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students are able to name the different forms and basic laws of thermodynamics and heat transfer. The students can discuss problems of thermodynamics and heat transfer using dimensionless characteristic numbers. The students are able to apply methods of thermodynamics and heat transfer to specific and practical problems. Students can analyze technically relevant problems of thermodynamics and heat transfer with help of the learned methods. The students are able to evaluate which of two processes is better suited to solve a problem of thermodynamics and heat transfer.	

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Title	Electrochemical Energy Engineering
Number	2520400
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	Written exam, 120 minutes or oral examination 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students can explain the functionality of electrochemical energy converters such as fuel cells, batteries and electrolysers and are able to describe the underlying electrochemical and physical processes. Participation in the course puts them in a position to name quality, purpose and operating range of the cells. Furthermore, they can select the appropriate electrochemical cell for a given application, analyze them with respect to reaction and transport kinetic on the basis of dynamic electrochemical measurement methods , design them based on fundamental physical equations and define adequate operation modes.	

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Specialisation Sustainable Energy and Process Engineering - Elective Modules	
ECTS	15

Title	
Number	2521000000
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	1 examination element: written exam, 90 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students gain knowledge of the structure, function, production and use of batteries, in particular lithium-ion batteries, and fuel cells as well as the recycling of the used materials. After completion of the lecture as well as theoretical and practical exercises, the students know the materials for batteries and fuel cells, the function of the batteries and fuel cells in detail and can describe their processing and the processes for manufacturing batteries and fuel cells, discuss and reflect on the entire material cycle from the material, through component and system manufacturing, the usage scenarios and subsequent recycling, and name and explain the relevant technologies	

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Title	Bioreactors and Bioprocesses
Number	2526340
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 120 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students can name and describe the different processes of bioprocess engineering. They are able to carry out calculations for the design and scale up of bioreactors. They compare different reactor systems on the basis of balances and are able to select and calculate the required process parameters on this basis. The students are also able to transfer the theoretical knowledge they have acquired to real reactors. The students can evaluate the suitability of different process parameters for a defined problem. The students can derive the analogy between mass, momentum and heat transport.	

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Title	Chemical Process Engineering
Number	2541320
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
Students can list how to characterize the essential elements of reaction systems. They are enabled to explain the behaviour of fluid dynamics, mixing and residence time for the reactor types STR, CSTR, PFR and CSTR-cascade. Furthermore, they can calculate this applying different models and name their field of application. Students are capable to explain the individual mechanisms of reactions for integral kinetics, heat and mass transfer, and can describe these quantitatively - also in the superposition. The participation in the lab exercise enables the students to organize themselves independently for the execution and evaluation as well as to present, calculate and interpret the results obtained.	

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Title	Fundamentals of Sustainable Product Development and Engineering Design
Number	2516500
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Introduction to Micro- and Nanotechnology
Number	2521590
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	1 examination element: Presentation on a selected topic of micro- and nanotechnology, consisting of a written elaboration of slides and an oral presentation
Course achievement	
Module grade composition	
Objective qualification	
After completion of the module, the students are able to present basic aspects of micro- and nanotechnology. They will understand the special features and modes of operation of miniaturized structures and systems They will know typical methods for the two different approaches of top-down and bottom-up generation of micro- and nanostructures. They can describe the special features of nanomaterials, differentiate between nanomaterials and nanostructures and can deduce which types of nanomaterials and micro- and nanosystems (such as sensors) exist and what the most important applications are.	

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Title	Introduction to Sustainable Bioproduction
Number	2526530
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Process Simulation
Number	2521600
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Specialisation: Sustainable Production

Specialisation Sustainable Production - Compulsory Modules	
ECTS	38

Title	Enterprise Organisation
Number	2523210
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Collaborative Work Sustainable Production
Number	2598140
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Energy Efficiency in Production Engineering
Number	2522930
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Energy Efficiency in Production Engineering
Number	2522930
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam+ (120 min) or oral exam+ (30 min)
Course achievement	presentation and/or written report in the context of a teamproject (On application, the result of the course achievement is taken into account in the assessment of the written examination+ or of the oral examination+, respectively, and can account maximum 20% of the respective grade.)
Module grade composition	
Objective qualification	

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Title	Production Technology
Number	2522420
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 120 minutes or oral exam 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
- Students are able to differentiate production engineering from other fields of mechanical engineering - Students are able to classify manufacturing processes according to DIN 8580 - Students are able to explain the process of industrially relevant production methods and their advantages and disadvantages - Students are able to select suitable manufacturing processes for applications - Students are able to enumerate and explain novel and research-oriented manufacturing processes in the field of lightweight construction - Students are able to explain the potentials and challenges of hybrid lightweight construction - Students are able to explain the interactions and connections between the disciplines of production, construction and materials engineering - Students are able to calculate and interpret parameters and key figures of machining	

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Title	Finite Element Methods
Number	2529310
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam of 120 minutes or oral exam of 60 minutes in groups
Course achievement	
Module grade composition	
Objective qualification	
After completing the course attendees will be able to describe the basics of the finite element method and calculate deformations using the taught elements. Shape functions can be selected with regard to the mathematical problem. Students can solve engineering motivated problems of elastostatics and heat conduction.	

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Title	Fundamentals of Sustainable Product Development and Engineering Design
Number	2516500
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Total Life-Cycle-Management
Number	2522990
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam+, 120 minutes or oral exam 30 minutes
Course achievement	presentation in the context of a teamproject (on application, the result of the course achievement is taken into account in the assessment of the written examination+. The course achievement can account maximum 20% of the grade of the written examination+)
Module grade composition	

Objective qualification

Students…
• … can spot and identify relevant challenges and interrelationships between global economic and ecological developments and place them within the framework of reference of Total Life Cycle Management.
• … can name the central elements of sustainable development and analyse them with the help of the framework.
• … are able to analyse life cycle oriented concepts in order to develop sustainable life cycles of technical products.
• … are able to think in complex dynamic systems and to outline the model of viable systems.
• … are able to distinguish between life-phase and life-cycle related disciplines and to discuss them with the help of the St. Gallen management concept and the framework of Total Life Cycle Management.
• … are able to reproduce the procedure of a life cycle assessment, naming the framework conditions (e.g. environmental impact, functional unit) and discuss the results of a life cycle assessment.
• … are able to independently carry out an economic impact analysis using the Life Cycle Costing method.
• … are able to organise themselves effectively within group work, to divide the work, to ensure that goals are achieved on time and to use solution-oriented communication.

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Title	Total Life-Cycle-Management
Number	2522990
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam+ (120 min) or oral exam+ (30 min)
Course achievement	presentation and/or written report in the context of a teamproject (On application, the result of the course achievement is taken into account in the assessment of the written examination+ or of the oral examination+, respectively, and can account maximum 20% of the respective grade.)
Module grade composition	

Objective qualification

Students…
• … can spot and identify relevant challenges and interrelationships between global economic and ecological developments and place them within the framework of reference of Total Life Cycle Management.
• … can name the central elements of sustainable development and analyse them with the help of the framework.
• … are able to analyse life cycle oriented concepts in order to develop sustainable life cycles of technical products.
• … are able to think in complex dynamic systems and to outline the model of viable systems.
• … are able to distinguish between life-phase and life-cycle related disciplines and to discuss them with the help of the St. Gallen management concept and the framework of Total Life Cycle Management.
• … are able to reproduce the procedure of a life cycle assessment, naming the framework conditions (e.g. environmental impact, functional unit) and discuss the results of a life cycle assessment.
• … are able to independently carry out an economic impact analysis using the Life Cycle Costing method.
• … are able to organise themselves effectively within group work, to divide the work, to ensure that goals are achieved on time and to use solution-oriented communication.

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Specialisation Sustainable Production - Elective Modules	
ECTS	25

Title	Actuators
Number	2538220
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students are able to distinguish a total of 12 different physical actuator principles with regard to their functionality and their application-specific properties and can draw conclusions about their possible applications. The students can define an actuator, describe the actuator principles and derive the factors influencing the actuator forces and actuator travel from the given mathematical equations. They are able to construct actuator concepts with a basic function (positioning movement). In addition, they can use the scaling laws to calculate how the power density and other characteristics of actuator principles behave when scaling and determine the consequences of this.	

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Title	Plant Engineering and Construction (ME)
Number	2521340
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam (120 minutes) or oral exam (30 minutes)
Course achievement	
Module grade composition	
Objective qualification	
After completion of the module, students are able to plan plants, to illustrate them in flowcharts and layout plans and to design machines and apparatuses mathematically. They are able to explain the processes involved in the construction of a plant and are able to avoid common problems.	

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Title	Automation of Industrial Manufacturing Processes
Number	2522610
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	Written exam, 120 minutes or oral exam 30 minutes
Course achievement	
Module grade composition	

Objective qualification

Students...

- are able to name automation technology devices (robot structures, control devices, transport systems, sensors, actuators...) and assign them to the respective scenarios (automotive, electronics and aviation industry).
- are able to classify the presented scenarios with regard to quantity, production costs and automation costs.
- gain the ability to analyse challenges arising in the scenarios and independently develop solutions based on the scenarios presented and transfer them to new problems.
- can use #Petri-Nets# to model complex process sequences in control systems.
- can use CFC programming (Continous Function Chart) to perform simple control tasks.

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Title	Introduction to Mechatronics
Number	2538230
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	2 examination elements: a) written exam, 45 minutes or oral exam 20 minutes (to be weighted 2,5/5 in the calculation of module mark) b) Seminar lecture, 20 minutes (to be weighted 2,5/5 in the calculation of module mark)
Course achievement	
Module grade composition	
Objective qualification	
Students are able to define and describe mechatronic systems and to name essential functions or components. They are able to discuss and apply approaches for the development of mechatronic systems (system engineering methods, development methods) and to describe analogies from the different technical domains mechanics, electrical engineering and computer science and to transfer them to application examples. Furthermore, students are able to explain sensors and actuators as essential components of mechatronic systems and their basic functional principles. In the course of the seminar, the students apply the lecture contents to an example of their choice. They are able to present the acquired knowledge (lecture) and discuss it in a team.	

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Title	Introduction to Metrology
Number	2511360
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 150 minutes
Course achievement	
Module grade composition	

Objective qualification

The students are familiar with the basics of measurement technology. That contains issues concerning preparations of the measurement and its realization as well as the evaluation and interpretation of the measured data.
The students are able to recognize and avoid or at least minimize possible error sources by understanding the interactions between measuring device, measuring object, environment and user. Beyond that, they can handle the measured data, in particular statistic methods enabling them to test the validity of data and to estimate a measurement uncertainty. Furthermore, the students get an overview of state-of-the-art metrology techniques determining variables in process monitoring and quality control.

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Title	Applied Electronics
Number	2538000000
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam 30 minutes
Course achievement	
Module grade composition	

Objective qualification

Students are able to name and describe all basic passive electrical components and to design their application. With the help of the given mathematical equations they are able to design, calculate and evaluate basic electronic circuits, starting with linear networks, passive filters and resonant circuits, rectifier and transistor circuits up to operational amplifiers.

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Title	Joining Technology
Number	2537210
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 120 minutes
Course achievement	
Module grade composition	

Objective qualification

After completion of the module „Joining Technology“, students understand the theoretical basics and methods for designing and executing joining connections. They are fully able to outline properties of different joining processes and can categorize processes based on selected criteria. Furthermore, the students gain the theoretical knowledge using selected examples of industrial applications of the individual joining processes. Furthermore, they are able to design concepts within the scope of joining suitability, joining processes and constructions according to critical requirements. At the end of the module, the students can derive potentials from joint connections.

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Title	Basics of Solids Process Engineering (ME)
Number	2521360
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam, 30 minutes
Course achievement	
Module grade composition	

Objective qualification

After completion of this module, students are able to name and describe disperse properties of particles, forces and motion of particles in fluids, interactions between particles and flows of fluids through particulate packings, to derive important mathematical relationships and to graphically illustrate these relationships. Furthermore, the students are able to describe particle size analysis as well as the basic operations of mechanical process engineering separation, mixing, comminution and agglomeration by applying the above described fundamentals and to calculate example processes. Furthermore, students are able to sketch and describe selected facilities of the basic operations.

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Title	Fundamentals of Microsystem Technology
Number	2538200
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	written exam, 90 minutes or oral exam 30 minutes
Course achievement	
Module grade composition	
Objective qualification	
The students are able to describe and evaluate the established manufacturing technologies of microsystems technology that are in line with the current state of the art and to determine their application. Furthermore, they are able to assess the factors that have an influence on the quality of the individual technologies (factors influenced by e.g. environmental conditions and mutual interference) and, on this basis, plan a realistic sequence for the fabrication of simple microtechnical components. They are able to represent and evaluate the materials frequently used for microsystems and their characteristic properties. Finally, students can transfer the possibilities of microtechnical manufacturing to simple application examples.	

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Title	Fundamentals of Sustainable Processes in Energy and Process Engineering
Number	2541470
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	Industrial Quality Management
Number	2511210
ECTS	5,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Integrated Modules	
ECTS	8

Title	
Number	2598180
ECTS	8,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Internship	
ECTS	10

Title	Internship
Number	2599650
ECTS	10,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Bachelor's Thesis	
ECTS	14

Title	Bachelor's Thesis Sustainable Engineering of Products and Processes
Number	2598150
ECTS	14,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Additional Courses

Title	Additional Courses
Number	2599340
ECTS	,0
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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Title	
Number	2599000000
ECTS	
Compulsory requirements	
Compulsory attendance	
Expected performance/ Type of examination	
Course achievement	
Module grade composition	
Objective qualification	

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