Karlsruher Institut für Technologie

Module Handbook
Bioengineering Master 2025 (Master of Science (M.Sc.))

SPO 2025

Winter semester 2025/26

Date: 03/09/2025

KIT DEPARTMENT OF CHEMICAL AND PROCESS ENGINEERING

Table Of Contents

1 General Information

1.1 Study program details

KIT-Department	KIT Department of Chemical and Process Engineering
Academic Degree	Master of Science (M.Sc.)
Examination Regulations Version	2025
Regular semesters	4 semesters
Maximum semesters	8 semesters
Credits	120
Language	German, some courses in English
Grade calculation	Weighted average by credits
Additional Information	Link to study program www.ciw.kit.edu Department https://www.ciw.kit.edu/1630.php Business unit Studium und Lehre https://www.sle.kit.edu/vorstudium/master-bioingenieurwesen.php

1.2 Qualification Goals

The focus of bioengineering is on process engineering in the context of an industrial, engineering-driven application of biological and biotechnological principles. In this way, bioengineering differs from natural sciences programs, biotechnology or molecular biotechnology, which deal primarily with the utilization of biological principles. Bioengineers make a crucial contribution to the development of interdisciplinary approaches for creating an energetically and materially sustainable, post-fossil economy.

The Master's program provides extensive detailed knowledge in engineering and natural sciences, which enables graduates to apply process engineering principles to biological material systems. In addition, students acquire skills in the application and development of digital tools. The Master's degree qualifies graduates to work scientifically and act responsibly within their professional activity and in the society.

Based on the Bachelor's program, the compulsory program in the first year focuses on advanced methodical and qualified fundamental knowledge with a main focus on biothermodynamics biotechnological procedures and processes that make an industrial utilization of biological systems possible. This knowledge is further advanced within two to four specialized courses elected by the students. An internship in industry or academia provides in-depth insight into the fields of activity of an engineer.

In the scope of the Master's thesis, students prove their ability to work on a problem within their field of expertise independently and in a defined time frame using scientific methods that correspond to the current state of research.

Graduates are qualified to analyze and solve problems using scientific methods and to abstract and formulate complex problems. They are also able to develop new methods, processes and products. Graduates are qualified to combine knowledge from various professional areas and to familiarize themselves systematically with new tasks. They can reflect non-technical impacts of engineering activities and consider those impacts by acting responsibly.

1.3 Acceptance Criterias

Whether admission is possible depends on your previous academic knowledge, i.e. the content of the Bachelor's degree course you have completed. You must provide evidence of the following academic achievements from your previous studies:

- Fundamentals of Mathematics and Natural Sciences 35 CP
- Fundamentals of Scientific Engineering 15 CP
- Thermodynamics and Transport processes 15 CP
- Fundamentals of Process Engineering 12 CP
- Biology and Biotechnology 15 CP
- Bachelor's thesis or equivalent 12 CP

If up to 15 CP are missing in a maximum of two of these areas, admission is possible on condition that the missing work is completed within the first three Master's semesters. Further details on the application can be found in the admission regulations

https://www.ciw.kit.edu/download/2024-07-29_MA-BIW-Zugangssatzung.pdf

Overview: Fields and Modules

Field	Module	Responsible	CP
Core Skills 2 mandatory modules	Process and Plant Design in Biotechnology	Holtmann	6
	Thermodynamics for Bioengineering	Enders, Zeiner	6
	At least 2 Credits Academic Work (z. B. Journal Club) Remaining credits: e. g. offers of the House of Competence of FORUM		4
Computer-aided Methods Process Engineeing	In the fields Computer-aided Methods and Process Engineering, 6 – 16 CP can be selected in each field, for a total of 22 CP. If 22 CP cannot be achieved exactly due to the CP scope of the individual modules, the 22 CP may be slightly exceeded.		22
Specialization	Two to four specializations can be chosen, each with a scope of 10–20 CP, for a total of 40 CP. If 40 LP cannot be achieved due to the scope of the individual modules, the 40 CP may be Slightly exceeded.		40
Internship	12 weeks of professional internship (industry) or research internship (KIT, other research institution). The research internship can be completed at KIT either as a block internship or part-time throughout the semester.		12
Thesis			30

The following specializations are electable:

- Biopharmaceutical Process Engineering
- Health Technology
- Industrial Biotechnology
- Design of Food Products
- Food Process Engineering
- Micro-Bioprocess Engineering
- New Bio-Production Systems - Electro-Biotechnology
- Conversion of Renewable Resources
- Water Technology

Curriculum - Example

1. Sem	Core skills 6 CP	Soft Skills 2 CP	CM 6 CP	Specialization 1 6 CP	Specialization 1 6 CP	Specialization 2 4 CP
2. Sem	Core Skills 6 CP	Soft Skills 2 CP	Process Eng. 4 CP	Process Eng. 6 CP	Specialization 3 6 CP	Specialization 2 4 CP
3. Sem	Research Internship (throughout semester) 12 CP		CM 6 CP	Specialization 3 4 CP	Specialization 3 4 CP	Specialization 2 6 CP
4. Sem	Thesis 30 CP					

- Computer-aided Methods (CM): 12 CP
- Process Engineering: 10 CP

- Specialization 1: 12 CP
- Specialization 2: 14 CP
- Specialization 3: 14 CP

3 Study Program Structure

Mandatory	
Master's Thesis	30 CP
Core Skills	12 CP
Process Engineering	6-16 CP
Computer-aided Methods	6-16 CP
Elective Area Specialization (Election: between 2 and 4 items as well as at least 40 credits)	
Specialization: Biopharmaceutical Process Engineering	10-20 CP
Specialization: Health Technology	10-20 CP
Specialization: Industrial Biotechnology	10-20 CP
Specialization: Design of Food Products	10-20 CP
Specialization: Food Process Engineering	10-20 CP
Specialization: Micro-Bioprocess Engineering	10-20 CP
Specialization: New Bio-Production Systems - Electro-Biotechnology	10-20 CP
Specialization: Conversion of Renewable Resources	10-20 CP
Specialization: Water Technology	10-20 CP
Mandatory	
Internship	12 CP
Interdisciplinary Qualifications	4 CP
Voluntary	
Additional Achievements *This field will not influence the calculated grade of its parent.*	

3.1 Master's Thesis

Credits
30

Mandatory				
M-CIWVT-107323	Module Master's Thesis	DE/EN	WS+SS	30 CP

3.2 Core Skills

Credits
12

Mandatory				
M-CIWVT-107357	Process and Plant Design in Biotechnology	DE	WS	6 CP
M-CIWVT-107386	Thermodynamics for Bioengineering	DE	SS	6 CP

3.3 Process Engineering

Credits
6-16

Process Engineering (Election: between 6 and 16 credits)				
M-CIWVT-105407	Additive Manufacturing for Process Engineering	EN	SS	6 CP
M-CIWVT-105782	Digital Design in Process Engineering	EN	WS	6 CP
M-CIWVT-107037	Dynamics of Process Engineering Systems	DE	SS	6 CP
M-CIWVT-104342	Solid Liquid Separation	DE	WS	8 CP
M-CIWVT-104383	Kinetics and Catalysis	DE	SS	6 CP
M-CIWVT-104353	Materials and Processes for Electrochemical Storage	DE	WS+SS	4 CP
M-CIWVT-105399	Mixing, Stirring, Agglomeration	DE	SS	6 CP
M-CIWVT-104378	Particle Technology	DE	SS	6 CP
M-CIWVT-104291	Refinery Technology - Liquid Fuels	DE	SS	6 CP
M-CIWVT-104329	Rheology of Polymers	DE	SS	4 CP
M-CIWVT-104352	Process and Plant Safety	DE	SS	4 CP
M-CIWVT-104330	Stability of Disperse Systems	DE	WS	4 CP
M-CIWVT-107039	Thermal Process Engineering II	DE	SS	6 CP
M-CIWVT-107040	Thermal Process Engineering III	DE	WS	6 CP
M-CIWVT-103073	Processing of Nanostructured Particles	DE	WS	6 CP
M-CIWVT-104351	Process Instruments and Machinery and Their Process Integration	DE	WS	4 CP
M-CIWVT-104371	Heat Exchangers	DE	WS	6 CP
M-CIWVT-104296	Hydrogen and Fuel Cell Technologies	DE	SS	4 CP

3.4 Computer-aided Methods

Credits
6-16

Computer-aided Methods (Election: between 6 and 16 credits)				
M-INFO-107198	Advanced Artificial Intelligence	EN	SS	6 CP
M-MATH-106634	Computational Fluid Dynamics and Simulation Lab	DE/EN	SS	4 CP
M-CIWVT-106319	Data-Based Modeling and Control	EN	WS	6 CP
M-CIWVT-106835	Data-Driven Process Engineering Models in Python	DE	WS	4 CP
M-INFO-107197	Deep Learning and Neural Networks	EN	SS	6 CP
M-CIWVT-104973	Digitization in Particle Technology	DE	WS	6 CP
M-CIWVT-106676	Introduction to Numerical Simulation of Reacting Flows	EN	WS	8 CP
M-CIWVT-106316	Nonlinear Process Control	DE/EN	WS	6 CP
M-CIWVT-107076	Numerical Simulation of Reacting Multiphase Flows	DE/EN	SS	8 CP
M-CIWVT-103072	Computational Fluid Dynamics	DE	WS	6 CP
M-CIWVT-106317	Optimal and Model Predictive Control	EN	SS	6 CP
M-MATH-101338	Parallel Computing		Irreg.	5 CP
M-CIWVT-106313	Principles of Constrained Static Optimization	EN	WS	4 CP
M-ETIT-105594	Process Analysis: Modeling, Data Mining, Machine Learning	DE	SS	3 CP
M-CIWVT-106537	Reactor Modeling with CFD	EN	SS	4 CP
M-CIWVT-107038	Simulation Technologies	DE	SS	6 CP

3.5 Specialization: Biopharmaceutical Process Engineering

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-103065	Biopharmaceutical Purification Processes	DE	WS	6 CP
M-CIWVT-105412	Industrial Aspects in Bioprocess Technology	DE	SS	4 CP
M-CIWVT-103066	Process Modeling in Downstream Processing	DE	SS	4 CP
M-CIWVT-106563	Production and Development of Cancer Therapeutics	DE	WS	4 CP
M-CIWVT-104329	Rheology of Polymers	DE	SS	4 CP
M-CIWVT-105399	Mixing, Stirring, Agglomeration	DE	SS	6 CP

3.6 Specialization: Health Technology

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-103065	Biopharmaceutical Purification Processes	DE	WS	6 CP
M-CIWVT-104266	Formulation of (Bio)pharmaceutical Therapeutics	DE	WS	4 CP
M-MACH-102720	Principles of Medicine for Engineers	DE	WS	4 CP
M-MACH-102702	Organ Support Systems	DE	SS	4 CP
M-CIWVT-106838	Biosensors	EN	WS+SS	4 CP
M-ETIT-106782	Modeling Physiological Systems	EN	SS	6 CP
M-ETIT-107343	Printed and Thin-Film Electronics	EN	WS	3 CP
M-MACH-107521	Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics	EN	WS	4 CP

3.7 Specialization: Industrial Biotechnology

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-107402	Plant and System Design	DE	WS+SS	6 CP
M-CIWVT-106837	Bioprocess Scale-up	EN	WS	6 CP
M-CIWVT-106501	Industrial Bioprocesses	DE	WS	4 CP
M-CIWVT-106678	Industrial Biocatalysis	DE	SS	4 CP
M-CIWVT-104273	Commercial Biotechnology	DE	SS	4 CP
M-CIWVT-106595	Bioreactor Development	DE	SS	4 CP

3.8 Specialization: Design of Food Products

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-107439	Emulsification Technology	DE	SS	4 CP
M-CIWVT-104388	Development of an Innovative Food Product	DE	WS+SS	6 CP
M-CHEMBIO-104620	Food Chemistry Basics	DE	SS	4 CP
M-CIWVT-106661	Alternative Protein Technologies	EN	SS	4 CP
M-CIWVT-105933	Introduction to Sensory Analysis	DE	SS	2 CP

3.9 Specialization: Food Process Engineering

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-106698	Process Engineering for the Production of Food from Plant-Based Raw Materials	DE	WS	4 CP
M-CIWVT-106699	Process Engineering for the Production of Food from Animal Origins	DE	SS	4 CP
M-CIWVT-105996	Extrusion Technology in Food Processing	EN	WS	4 CP
M-CIWVT-105932	Seminar of Food Processing in Practice	DE	WS	2 CP
M-CIWVT-107439	Emulsification Technology	DE	SS	4 CP
M-CIWVT-104330	Stability of Disperse Systems	DE	WS	4 CP

3.10 Specialization: Micro-Bioprocess Engineering

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-107424	Microsystems in Bioprocess Engineering	EN	SS	4 CP
M-CIWVT-104350	Microfluidics	DE	WS	4 CP
M-CIWVT-107433	Microfluidics Lab	DE	WS	2 CP
M-CIWVT-106564	Single-Cell Technologies	EN	WS	4 CP
M-MACH-100489	BioMEMS - Microsystems Technologies for Life Sciences and Medicine I	DE	WS	4 CP
M-MACH-100490	BioMEMS - Microsystems Technologies for Life Sciences and Medicine II	DE	SS	4 CP
M-MACH-100491	BioMEMS - Microsystems Technologies for Life Sciences and Medicine III	DE	SS	4 CP
M-MACH-105483	BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV	DE/EN	WS	4 CP
M-MACH-105484	BioMEMS - Microfludic Chipsystems V	DE/EN	WS	4 CP

3.11 Specialization: New Bio-Production Systems - Electro-Biotechnology

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-106518	Electrobiotechnology	DE	WS	6 CP
M-CIWVT-106816	C1-Biotechnology	DE	WS	6 CP
M-CHEMBIO-106204	Molecular Biology and Genetics	DE	WS	5 CP
M-ETIT-105883	Electrocatalysis	EN	SS	5 CP
M-CHEMBIO-106697	Electrochemistry	DE	Irreg.	3 CP
M-ETIT-107005	Batteries, Fuel Cells, and Electrolysis	EN	WS	6 CP

3.12 Specialization: Conversion of Renewable Resources

Credits
10-20

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-104422	Processes and Process Chains for Renewable Resources	DE	SS	6 CP
M-CIWVT-105295	Biotechnological Use of Renewable Resources	DE	WS	4 CP
M-CIWVT-104397	Innovation Management for Products & Processes in the Chemical Industry	DE/EN	WS	4 CP
M-CIWVT-104288	Biomass Based Energy Carriers	DE	WS	6 CP
M-CIWVT-104570	Biobased Plastics	DE	WS	4 CP
M-CIWVT-106698	Process Engineering for the Production of Food from Plant-Based Raw Materials	DE	WS	4 CP

3.13 Specialization: Water Technology

Credits
10-20

Election regulations
Elections in this field require confirmation.

Elective Area (Election: between 10 and 20 credits)				
M-CIWVT-103407	Water Technology	EN	WS	6 CP
M-CIWVT-103438	Fundamentals of Water Quality	EN	WS	6 CP
M-CIWVT-105903	Industrial Wastewater Treatment	EN	SS	4 CP
M-CIWVT-105380	Membrane Technologies in Water Treatment	EN	SS	6 CP
M-CIWVT-103440	Practical Course in Water Technology	EN	WS	4 CP
M-CIWVT-103441	Biofilm Systems	EN	SS	4 CP
M-CIWVT-104401	NMR for Engineers	DE	WS	6 CP
M-CIWVT-105890	NMR Methods for Product and Process Analysis	DE/EN	WS	4 CP

3.14 Internship

Credits
12

Elective Area (Election: 1 item)				
M-CIWVT-107422	Internship	DE	WS+SS	12 CP
M-CIWVT-107423	Research Internship	DE	WS+SS	12 CP

3.15 Interdisciplinary Qualifications

Credits
4

Interdisciplinary Qualifications (Election: at least 4 credits)				
M-CIWVT-106526	Journal Club - Novel Bioproduction Systems	DE/EN	WS	4 CP

3.16 Additional Achievements

Additional Examinations (Election: at most 30 credits)				
M-FORUM-106753	Supplementary Studies on Science, Technology and Society	DE	WS+SS	16 CP

4 Modules

M 4.1 Module: Additive Manufacturing for Process Engineering [M-CIWVT-105407]

Coordinators: TT-Prof. Dr. Christoph Klahn
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	5	2

Mandatory			
T-CIWVT-110902	Additive Manufacturing for Process Engineering - Examination	5 CP	Klahn
T-CIWVT-110903	Practical in Additive Manufacturing for Process Engineering	1 CP	Klahn

Assessment
Learning control consists of:

- Practical (ungraded)
- Oral examination with a duration of about 30 minutes

Prerequisites
Practical in Additive Manufaturing for Process Engineeing is a prerequisite for the oral exam.

Competence Goal
Students are familiar with the concept of a fully digital fabrication chain using and linking together modeling and simulation, computer aided design and 3D printing. They know the most important 3D printing methods suitable for process engineering applications. Moreover, they are able to use standard tools for 3D data generation and they already own hands on practical experience with the use of a metal 3D printer for fabrication of highly precise parts with complex shape.

Content
The rationale for additive manufacturing and key aspects of this approach are explained. An overview of different methods and materials for 3D printing is given with a focus on the use of 3D printed parts or fully functional devices in chemical and process engineering. Tools for 3D data generation for additive manufacturing are introduced and design rules for selected 3D printing methods are explained. Illustrative examples for 3D printed components and functional devices in process engineering are presented and discussed based on literature and own research. In the practical, students will work together in small groups on a fully digital fabrication of functional parts by selective laser melting of metal powder going through a cycle of 3D data generation, 3D printing, and finishing of the printed parts.

Module Grade Calculation
Module grade is the grade of the oral examination.

Workload
Lectures: 30 h

Practical: 16 h (8 experiments)

Homework: 90 h

Exam Preparation: 44 h

Total: 180 h

Literature

- Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani: Additive Manufacturing Technologies, Springer Nature Switzerland, 2021, DOI: 10.1007/978-3-030-56127-7
- Christoph Klahn, Mirko Meboldt, Filippo Fontana, Bastian Leutenecker-Twelsiek, Jasmin Jansen, Daniel Omidvarkarjan: Entwicklung und Konstruktion für die Additive Fertigung, Vogel Business Media, Würzburg, 2021, ISBN 978-3-8343-3469-5

M 4.2 Module: Advanced Artificial Intelligence [M-INFO-107198]

Coordinators: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114220	Advanced Artificial Intelligence	6 CP	Niehues

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
- The students know the relevant elements of a technical cognitive system.
- The students understand the algorithms and methods of AI to model cognitive systems.
- The students are able to understand the different sub-components to develop and analyze a system .
- The students can transfer this knowledge to new applications, as well as analyze and compare different methods.

Content
Due to the successes in research, AI systems are increasingly integrated into our everyday lives. These are, for example, systems that can understand and generate language or analyze images and videos. In addition, AI systems are essential in robotics in order to be able to develop the next generation of intelligent robots .

Based on the knowledge of the lecture “Introduction to AI”, the students learn to understand, develop and evaluate these systems.
In order to bring this knowledge closer to the students, the lecture is divided into 4 parts. First, the lecture investigates method of perception using different modalities. The second part deals with advanced methods of learning that go beyond supervised learning. Then methods are discussed that are required for the representation of knowledge in AI systems. Finally, methods that enable AI systems to generate content are presented.

Workload
Lecture with 3 SWS + 1 SWS exercise , 6 CP.
6 LP corresponds to approx. 180 hours, of which
approx. 45 hours lecture attendance
approx. 15 hours exercise visit
approx. 90 hours post-processing and processing of the exercise sheets
approx. 30 hours exam preparation

M 4.3 Module: Alternative Protein Technologies [M-CIWVT-106661]

Coordinators: PD Dr.-Ing. Azad Emin
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Design of Food Products

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-CIWVT-113429	Alternative Protein Technologies	4 CP	Emin

Assessment
The learning control is an oral examination lasting approx. 20 minutes.

Prerequisites
None

Competence Goal
Upon successful completion of this module, students will be able to:

1. Understand and describe the fundamental aspects of various alternative proteins, including plant-based, fermentation-derived, and cultivated meat and dairy alternatives.
2. Evaluate the nutritional profiles and sensory properties of meat and dairy substitutes.
3. Grasp the basic principles of material science that are applicable to the development of alternative proteins.
4. Gain familiarity with precision fermentation processes and their practical applications in creating alternative proteins.
5. Recognize the significance and methodology of extrusion technology in enhancing the texture and structure of plant-based proteins.
6. Develop a basic understanding of product design and marketing strategies tailored for alternative proteins.
7. Identify the key technological processes in alternative protein production and their environmental implications.
8. Acquire a foundational awareness of the market dynamics and emerging trends within the alternative protein sector.
9. Participate in practical projects and engage with industry professionals to apply learned concepts in real-world contexts.

Content
This course is designed to offer an academic and technical exploration into the field of alternative protein technologies. It encompasses a detailed study of the science, engineering, and technological aspects behind the development of plant-based, fermentation-derived, and cultivated protein products. Key focus areas include the sustainability challenges associated with conventional meat and dairy production, and the potential of alternative proteins to address these issues.

Participants will delve into the material science principles that guide the development of meat and dairy substitutes, examining texture, structure, and sensory properties. The course will cover advanced topics such as precision fermentation and its role in alternative protein production, the technology behind cultivated meat, and the application of extrusion technology in creating plant-based protein structures.

The curriculum also includes a comprehensive study of the production processes, nutritional profiles, and environmental impacts of various alternative protein sources such as legumes, insects, algae, and mycoprotein. Through this course, students will gain a thorough understanding of the current technologies, challenges, and innovations in the field, equipping them with the knowledge to contribute to the future advancements in the alternative protein sector.

Module Grade Calculation
The module grade is the grade of the oral exam.

Additional Information
Course location: Seminar room, nexnoa GmbH, Durmersheimerstr. 188A, 76189 Karlsruhe

Workload

- Attendance time: 30 hrs.
- Preparation and wrap-up lectures: 30 hrs.
- Exam preparation: 60 hrs.

M 4.4 Module: Batteries, Fuel Cells, and Electrolysis [M-ETIT-107005]

Coordinators: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Specialization: New Bio-Production Systems - Electro-Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-ETIT-113986	Batteries, Fuel Cells, and Electrolysis	6 CP	Krewer

Assessment
Success control takes place in the form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
Students gain an understanding of batteries, fuel cells and electrolysis including their application, design, and behavior. They acquire in-depth knowledge of the transport and charge transfer processes in them, their impact on performance and design, and the characteristics of the most frequent types of batteries, fuel and electrolysis cells. They understand how to analyze and characterize them using measurement methods and modeling. A practical insight into current areas of application and research topics of electrochemical energy storage and conversion allows them to relate the course work to demands of the society and for R&D. They are able to communicate with specialists from related disciplines in the field of (application of) batteries, fuel cells and electrolysis and can actively contribute to the opinion-forming process in society with regard to energy technology issues.

Content
The course introduces batteries, fuel cells and electrolysis and their use for sustainable mobile and stationary energy supply and storage. The course is divided into five sections. The first part covers the role of batteries, fuel cells and electrolysis for renewable energy storage and electrification of the energy system and the present applications. This is followed by a fundamentals part, where the processes in electrochemical cells at open circuit and during operation and their relation to cell performance and behavior are discussed. It contains thermodynamics, kinetics, transport and performance measures. The third part deals with the working principle, design and operation of fuel cells and electrolysis and the particularities of the different cell types. This is followed by a similar part for batteries. Finally, dynamic and stationary methods for characterizing the cells are covered.

Group project

As part of the coursework, student groups work on the design of a battery, fuel cell or electrolyser for a given application during the semester. This includes literature research on cell type, materials and material data as well as the dimensioning and energetic evaluation of the cell. The results are documented in a short technical report.

Module Grade Calculation
The module grade is the grade of the written examination.

Workload

1. Lecture attendance time: 15 * 2 h = 30 h
2. Preparation and follow-up time for lecture: 15 * 5 h = 75 h
3. Exercise attendance time: 7 * 2 h = 14 h
4. Preparation and follow-up time for exercise: 7 * 4 h = 28 h
5. Group work including writing of a report: 33 h
6. Exam preparation and attendance: included in preparation and follow-up time.

Total: 180 h = 6 CP

M 4.5 Module: Biobased Plastics [M-CIWVT-104570]

Coordinators: Prof. Dr. Ralf Kindervater
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Conversion of Renewable Resources

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-109369	Biobased Plastics	4 CP	Kindervater

Assessment
Verteifungsfach:

The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Technisches Ergänzungsfach or a large number of aatudents:

The examination is a written examination with a duration of 90 minutes (section 4 subsection 2 number 1 SPO).

The grade of the oral examination is the module grade.

Prerequisites
None

Workload
120 h:

- Attendance time (Lecture): 30 h
- Homework: 60 h
- Exam Preparation: 30 h

M 4.6 Module: Biofilm Systems [M-CIWVT-103441]

Coordinators: Dr. Andrea Hille-Reichel
Dr. Michael Wagner
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-CIWVT-106841	Biofilm Systems	4 CP	Hille-Reichel, Wagner

Assessment
The learning control is an oral exam lasting approx. 20 minutes.

Prerequisites
None

Competence Goal
Students are able to describe the structure and function of biofilms in natural habitats and technical applications and explain the main influencing factors and processes for the formation of certain biofilms. They are familiar with methods for visualizing the structures.

Content
This lecture aims at providing an overview of biofilm systems, their development, functions, applications, and the techniques used to investigate them. Thus, topics involved will include basics of (biofilm) microbiology, natural (environmental) biofilm systems, their application in technical systems (reactors), and methods used to quantify biofilm development and performance (i.e., imaging techniques, digital image analysis).

Module Grade Calculation
Grande of the module is the grade of oral examination.

Workload
Attendance time: 30 h
Preparation/follow-up: 30 h
Examination + exam preparation: 60 h

M 4.7 Module: Biomass Based Energy Carriers [M-CIWVT-104288]

Coordinators: Dr.-Ing. Siegfried Bajohr
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Conversion of Renewable Resources

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-108828	Energy from Biomass	6 CP	Bajohr

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

Competence Goal
The course mediates fundamentals and process engineering aspects of biomass conversion and conditioning processes. The students learn to understand and to evaluate processes for biomass utilization by balancing mass and energy streams. Taking into account regional and global feedstock potentials the students are enabled to choose the most efficient conversion technologies.

Content
Fundamentals on biomass and its production pathways to energy carriers like substitute natural gas (SNG), bio diesel or other fuels.

Production, properties, and characterization of biomass.

Potential and sustainability; energy demand and supply, potentials today and in the future, CO2 emissions and reduction potential.

Utilization and conversion of biogenic oils and fats.

Biochemical conversion to liquid products like alcohols; fermentation to biogas and its upgrading.

Thermochemical conversion of biomass via pyrolysis and gasification; examples for synthesis processes (FT-, CH4-, CH3OH-, DME-synthesis).

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 45 h
- Homework: 75 h
- Exam Preparation: 60 h

Literature

- Kaltschmitt, M.; Hartmann (Ed.): Energie aus Biomasse, 2. Aufl., Springer Verlag 2009.
- Graf, F.; Bajohr, S. (Hrsg.): Biogas: Erzeugung – Aufbereitung – Einspeisung, 2. Aufl., Oldenbourg Industrieverlag 2013.

M 4.8 Module: BioMEMS - Microfludic Chipsystems V [M-MACH-105484]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-111069	BioMEMS - Microfludic Chipsystems V	4 CP	Guber, Rajabi

Assessment
Oral exam (20 min)

Prerequisites
none

Competence Goal
The students master the basics of microfluidics. They are able to develop, manufacture and test microfluidic systems in an application-oriented manner. They master applications such as Lab-on-chip, Organ-on-chip, Body-on-chip.

Content
Introduction in microtechnical production processes and biomaterials. Detailed application examples from the fields of lab-on-chip, organ-on-chip and body-on-chip.

Workload
Literature: 19 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Teaching and Learning Methods
Lecture

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 4.9 Module: BioMEMS - Microsystems Technologies for Life Sciences and Medicine I [M-MACH-100489]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-MACH-100966	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I	4 CP	Guber

Assessment
Written exam (75 min)

Prerequisites
none

Competence Goal
Professional qualification goals:
Students will be able to describe basic microtechnical manufacturing processes (e.g. LIGA, silicon microtechnology, laser micromachining) and analyze their suitability for biomedical applications.
They are able to compare different microfluidic components (e.g. microchannels, micropumps, microfilters) and explain their function in the context of µTAS and lab-on-chip systems.
Students will be able to explain the properties and possible applications of biomaterials and sterilization processes for microsystems in medical technology.
Furthermore, they can evaluate the interactions between microtechnical production and biomedical application and transfer them to selected case studies from the life sciences.
Interdisciplinary qualification goals:
Students will be able to recognize interdisciplinary connections between technology, biology and medicine and argue in a structured manner in discussions. Furthermore, they will be able to critically reflect on current developments and literature in the field of microsystems technology for life science applications and assess their relevance for research and industry.

Content
The lecture will first address relevant microtechnical manufacturing methods. Then,
selected biomedical applications will be presented, as the increasing use of
microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical
products, instruments, and operation and analysis systems.

Introduction into various microtechnical manufacturing methods: LIGA, Micro milling, Silicon Micromachining, Laser Microstructuring, µEDM, Metal-Etching
Biomaterials, Sterilisation.
Examples of use in the life science sector: basic micro fluidic strucutures: micro channels, micro filters, micromixers, micropumps, microvalves, Micro and nanotiter plates, Microanalysis systems (µTAS),
Lab-on-chip applications.

Module Grade Calculation
Written exam

Workload
Literature: 20 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Teaching and Learning Methods
Lecture

Literature

Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 4.10 Module: BioMEMS - Microsystems Technologies for Life Sciences and Medicine II [M-MACH-100490]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-100967	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II	4 CP	Guber

Assessment
Written exam (75 min)

Prerequisites
None

Competence Goal
Professional qualification goals:
Students will be able to describe modern microfluidic systems (e.g. Lab-CD, microarrays, biochips) and analyze their functional principles in the context of biomedical applications. They will be able to explain and evaluate biohybrid cell-chip systems and their use in tissue engineering and drug testing.
Students will be able to explain the structure and function of microprocess engineering components (e.g. microreactors, microfluidic measuring cells) and assess their use in spectroscopic investigations.
They can examine specific microsystems technology solutions for medical applications in anesthesia, intensive care medicine and infusion therapy and compare their principles of action.
They will be able to describe micro- and nanoscale technologies (e.g. in nanosurgery or neuroprosthetics) in a differentiated manner and assess their significance for future therapy concepts.

Interdisciplinary qualification goals:
Students will be able to recognize and reflect on interdisciplinary connections between technology, biology and medicine and argue for them in scientific discussions.
Furthermore, they are able to analyze current scientific publications on applications of microsystems technology in the life sciences and critically discuss their relevance.
They will be able to reflect on technological developments in the field of microsystems technology with regard to ethical, social and regulatory aspects.

Content
The lecture will first shortly address some relevant microtechnical manufacturing methods. Then,
selected biomedical applications will be presented, as the increasing use of
microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical
products, instruments, and operation and analysis systems.

Examples of use in Life-Sciences and biomedicine: Microfluidic Systems:
LabCD, Protein Cristallisation
Microarrys
Tissue Engineering
Cell Chip Systems
Drug Delivery Systems
Micro reaction technology
Microfluidic Cells for FTIR-Spectroscopy
Microsystem Technology for Anesthesia, Intensive Care and Infusion
Analysis Systems of Person´s Breath
Neurobionics and Neuroprosthesis
Nano Surgery

Module Grade Calculation
Written exam

Workload
Literature: 20 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Teaching and Learning Methods
Lecture

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994

M. Madou
Fundamentals of Microfabrication

M 4.11 Module: BioMEMS - Microsystems Technologies for Life Sciences and Medicine III [M-MACH-100491]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-MACH-100968	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III	4 CP	Guber

Assessment
Written exam (75 min)

Prerequisites
none

Competence Goal
The lecture will first shortly address some relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Examples of use in minimally invasive therapy
Minimally invasive surgery (MIS)
Endoscopic neurosurgery
Interventional cardiology
NOTES
OP-robots and Endosystems
License of Medical Products and Quality Management

Workload
Literature: 20 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994

M. Madou
Fundamentals of Microfabrication

M 4.12 Module: BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV [M-MACH-105483]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-MACH-106877	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV	4 CP	Ahrens, Guber

Assessment
Oral exam (20 min)

Prerequisites
none

Competence Goal
The students get to know selected areas of application in the life sciences. They will be able to design and develop novel products for different fields of application in the life sciences, as well as implement them in production technology.

Content
Examples from the life science sector: biosensor technology, microfluidic basic structures and systems, micro-assembly, medical implants, micro-process engineering, optofluidics, medical products law.

Workload
Literature: 19 h

Lessions: 21 h

Preparation and Review: 50 h

Exam preparation: 30 h

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011

M 4.13 Module: Biopharmaceutical Purification Processes [M-CIWVT-103065]

Coordinators: Prof. Dr. Jürgen Hubbuch
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Biopharmaceutical Process Engineering
Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-106029	Biopharmaceutical Purification Processes	6 CP	Hubbuch

Assessment
The examination is a written examination with a duration of 120 minutes (section 4 subsection 2 number 1 SPO).

The grade of the written examination is the module grade.

Prerequisites
None

Competence Goal
Process development of biopharmaceutical processes

Content
Detailed discussion of biopharmaceutical purification processes

Workload

- Attendance time (Lecture): 60 h
- Homework: 90 h
- Exam Preparation: 30 h

Teaching and Learning Methods

- 22705 - Biopharmazeutische Aufarbeitungsverfahren, 3V
- 22706 - Übung zu Biopharmazeutische Aufarbeitungsverfahren, 1Ü

Literature
Vorlesungsskript

M 4.14 Module: Bioprocess Scale-up [M-CIWVT-106837]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Industrial Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	2

Mandatory			
T-CIWVT-113712	Bioprocess Scale-up	6 CP	Grünberger

Assessment
Learning control is an oral exam lasting approx. 30 minutes.

Competence Goal
Upon completion of the course, students will be able to:

Subject-Specific and Methodological Competencies

- Understand the fundamentals of scaling laws.
- Demonstrate knowledge of key scale-up strategies.
- Apply essential knowledge and toolsets required for the scale-up of bioprocesses.
- Recognize potential pitfalls and challenges during the scale-up process.
- Identify and implement best practices for the scale-up of bioprocesses.
- Bridge the gap between laboratory research and industrial production.

Social and Self-Competence

- Identify and summarize the key elements involved in bioprocess scale-up.
- Communicate effectively and collaborate with experts from various disciplines involved in bioprocess scale-up.
- Demonstrate critical thinking, creativity, and problem-solving skills necessary for scaling up novel bioprocesses.

Content
Biopharmaceuticals, enzymes, and biological materials used in food supplements are commonly produced through the cultivation of bacteria, yeast, fungi, plant, or animal cells in bioreactors. Regardless of the specific bioprocess, efficiency in terms of time, cost, and resource utilization is essential. Typically, these bioprocesses are developed initially at a small laboratory scale and then progressively transferred to larger volumes until reaching commercial industrial production. This critical transition is known as the scale-up of bioprocesses.

The objective of this course is to provide students with the fundamental knowledge and practical skills required to successfully scale-up biotechnological processes from laboratory to industrial scale. To achieve this, the course introduces key methods, concepts, and tools that form the foundation for effective scale-up of biochemical processes.

The course begins with an introduction to scaling laws, which are essential for understanding how process parameters change with scale. Examples from biology will be given. Following this, general scale-up methods are presented that enable transferring processes while maintaining performance and product quality. Industrial strategies and procedures are then discussed, supported by real-world examples and case studies. Finally, emerging trends and challenges in bioprocess scale-up are explored, highlighting innovative technologies and addressing future obstacles in the field. Through a combination of theoretical concepts, practical examples, and real-world case studies, this lecture aims to equip participants with the ability to develop and implement suitable scale-up strategies.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload

- Lectures and exercises: 45 hrs
- Homework: 95 hrs
- Exam preparation: 40 hrs

Recommendations
Fundamentals of Bioprocess Engineering.

Literature
No specific textbook is recommended.

M 4.15 Module: Bioreactor Development [M-CIWVT-106595]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Industrial Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-CIWVT-113315	Bioreactor Development	4 CP	Holtmann

M 4.16 Module: Biosensors [M-CIWVT-106838]

Coordinators: Dr. Gözde Kabay
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	English	4	1

Mandatory			
T-CIWVT-113714	Biosensors	4 CP	Kabay

M 4.17 Module: Biotechnological Use of Renewable Resources [M-CIWVT-105295]

Coordinators: Prof. Dr. Christoph Syldatk
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Conversion of Renewable Resources

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	3

Mandatory			
T-CIWVT-113237	Biotechnological Use of Renewable Resources	4 CP	Syldatk

Assessment
The learning control is an oral examination lasting approx. 20 minutes.

Prerequisites
None

Competence Goal
This lecture conveys the role of biotechnological processes in a future bioeconomy. Possible raw materials, their preparation and subsequent biotechnological implementation into energy carriers, platform chemicals and special microbial products are presented.

Content
After an introduction to the basics of a future bioeconomy and the comparison of chemical and biotechnological industrial processes using renewable resources, their preparation for biotechnological use and their implementation into energy sources (methane, ethanol), platform chemicals (lactate, dicarboxylic acids, amino acids) and special microbial products (polysaccharides, biosurfactants, flavoring substances) and coupling products like bioplastics. The examples of sugar production, papermaking and ethanol production explain various biorefinery concepts.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload

- Lectures: 45 h
- Homework: 45 h
- Exam Preparation: 30 h

M 4.18 Module: C1-Biotechnology [M-CIWVT-106816]

Coordinators: Dr. Anke Neumann
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: New Bio-Production Systems - Electro-Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-113677	C1-Biotechnology Exam	4 CP	Neumann
T-CIWVT-113678	C1-Biotechnology Presentation	2 CP	Neumann

M 4.19 Module: Commercial Biotechnology [M-CIWVT-104273]

Coordinators: Prof. Dr. Ralf Kindervater
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Industrial Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-CIWVT-108811	Commercial Biotechnology	4 CP	Kindervater

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

In case of large number of participants the examination is a written examination with a duration of 60 minutes (section 4 subsection 2 number 1 SPO).

Prerequisites
None

Module Grade Calculation
The grade of the oral or written examination is the module grade.

Workload
Lectures: 30 h

Homework: 50 h

Exam Preparation: 40 h (about one week)

M 4.20 Module: Computational Fluid Dynamics [M-CIWVT-103072]

Coordinators: Prof. Dr.-Ing. Hermann Nirschl
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-106035	Computational Fluid Dynamics	6 CP	Nirschl

Assessment
Learning control is a written examination lasting 90 minutes

Prerequisites
None

Competence Goal
Learning the fundamentals of CFD for the calculation of flow problems.

Content
Navier-Stokes equitations, numerical schemes, turbulence, multiphase flows.

Module Grade Calculation
The module grade is the grade of the written examination.

Workload

- Attendance time (Lecture): 64 h
- Homework: 56 h
- Exam Preparation: 601 h

Literature

- Nirschl: Skript zur Vorlesung CFD
- Ferziger, Peric: Numerische Strömungsmechanik
- Oertel, Laurien: Numerische Strömungsmechanik

M 4.21 Module: Computational Fluid Dynamics and Simulation Lab [M-MATH-106634]

Coordinators: PD Dr. Mathias Krause
Organisation: KIT Department of Mathematics
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German/English	4	2

Mandatory			
T-MATH-113373	Computational Fluid Dynamics and Simulation Lab	4 CP	Frank, Krause, Simonis, Thäter

Assessment
For their final project, students prepare a written report, usually 10-15 pages long, which is graded.

Prerequisites
none

Competence Goal
Students are able to jointly model problems beyond their own discipline and simulate them on high-performance computers. They have acquired a critical distance to results and their presentation. They can defend the results of projects in disputes. They have understood the importance of stability, convergence and parallelism of numerical methods from their own experience and are able to evaluate errors in modeling, approximation, computing and presentation.

Content
Lecture part: Introduction to modeling and simulations, introduction to associated numerical methods, introduction to associated software and high-performance computer hardware

Own group work: Working on 1-2 projects in which modelling, discretization, simulation and evaluation (e.g. visualization) are carried out for specific topics from the catalog. The catalog includes e.g: Diffusion processes, turbulent flows, multiphase flows, reactive flows, particle dynamics, optimal control and optimization under constraints, stabilization methods for advection-dominated transport problems.

Module Grade Calculation
The module grade is the grade of the final project.

Workload
Total workload: 120 hours

Attendance: 60 hours

- lectures and examination

Self-studies: 60 hours

- follow-up and deepening of the course content,
- work on projects and report,
- literature study and internet research relating to the course content

Recommendations
Basic knowledge of the analysis of boundary value problems and of numerical methods for differential equations is recommended. Knowledge of a programming language is strongly recommened.

M 4.22 Module: Data-Based Modeling and Control [M-CIWVT-106319]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	5	1

Mandatory			
T-CIWVT-112827	Data-Based Modeling and Control	6 CP	Meurer

Assessment
Learning control is an oral examination with a duration of about 45 minutes.

Prerequisites
none

Competence Goal
Students have an in-depth understanding of methods and concepts of data-based modeling and control of dynamic systems, including machine learning techniques and corresponding optimization methods. They understand the underlying mathematical concepts and can apply them to new problems. They are able to apply these methods independently to specific problems and familiarize themselves with further literature on their own.

Content
The module covers basic concepts and fundamentals of data-based approaches for modeling and control design for dynamical systems and processes. Data-based approaches for modeling, also called system identification, are used to identify a mathematical description of the considered system from the available input and output data. Data-based approaches for control design compute the controller without an a priori known model of the system. Extensions to learning-based control are addressed, where in principle machine learning techniques are used to learn a model or a controller for a given system.

Problem sets are considered in the exercises to apply the developed methods.

Module Grade Calculation
The grade of the module is the grade of the oral exam.

Workload
Attendance time: Lectures: 30 hrs. Exercises: 15 hrs.

Self-study: 75 hrs.

Exam preparation: 60 hrs.

Literature

- T. Meurer: Data-based Modeling and Control, Lecture Notes.
- S.L. Brunton, J.N. Kutz: Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control, Cambridge University Press, 2022.
- D. Bertsekas: Reinforcement Learning and Optimal Control, Athena Scientific, 2019.
- D.H. Owens: Iterative Learning Control, Springer, 2016.
- Various recent publications, which will be discussed in lecture.

M 4.23 Module: Data-Driven Process Engineering Models in Python [M-CIWVT-106835]

Coordinators: Dr.-Ing. Frank Rhein
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-113708	Data-Driven Models in Python - Process Engineering Project	3 CP	Rhein
T-CIWVT-113709	Data-Driven Process Engineering Models in Python - Exam	1 CP	Rhein

M 4.24 Module: Deep Learning and Neural Networks [M-INFO-107197]

Coordinators: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-INFO-114219	Deep Learning and Neural Networks	6 CP	Niehues

Assessment
See partial achievements (Teilleistung)

Prerequisites
See partial achievements (Teilleistung)

Competence Goal
Students will learn about the structure and function of different types of neural networks.

Students should learn the methods for training the various networks and their application to problems.

Students should learn the areas of application of the different types of networks.

Given a concrete scenario, students should be able to select the appropriate type of neural network.

Content
This module introduces the use of neural networks for the solution of solving various problems in the field of machine learning, such as classification, prediction, control or inference. or inference. Different types of neural networks are covered and their areas of application are illustrated using examples.

Workload
180h.

Recommendations
Prior successful completion of the core module "Cognitive Systems" is recommended.

M 4.25 Module: Development of an Innovative Food Product [M-CIWVT-104388]

Coordinators: Dr.-Ing. Ulrike van der Schaaf
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Design of Food Products

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	2 terms	German	4	2

Mandatory			
T-CIWVT-108960	Development of an Innovative Food Product	3 CP	van der Schaaf
T-CIWVT-111010	Development of an Innovative Food Product - Presentation	3 CP	van der Schaaf

Assessment
The learning control consists of:

- Seminar/ Presentation
- written elaboration/ exposé

Prerequisites
None

Competence Goal
Students can use their knowledge on food products and their processing to develop an innovative food product of their own. They also can develop a suitable process for its production with regards to energy efficiency and sustainability. Students are able to use basic principles of scale up in the food industry and to use strategies to ensure food quality and safety on a large scale. They can evaluate these concepts regarding their own food product. They understand basic concepts of marketing and packaging technology and can apply those concepts to their innovative product and analyse them. Students can apply basic principles of project management and evaluate them regarding the development of their food product.

Content
Development of a food product consumer ready (aspects included are amongst others food quality and safety, scale up, energy efficiency, sustainability, marketing and packaging); project management

Module Grade Calculation
50 % presentation (individual grade), 50 % written elaboration (group grade)

Additional Information
There is an opportunity to participate in the competition "EcoTrophelia".

The maximum number of participants is limited. Admission is based on a selection interview.

Workload

- Lab work: 100 h
- Homework: 20 h
- Written elaboration: 30 h
- Seminar and presentation: 30 h

M 4.26 Module: Digital Design in Process Engineering [M-CIWVT-105782]

Coordinators: TT-Prof. Dr. Christoph Klahn
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-CIWVT-111582	Digital Design in Process Engineering - Laboratory	3 CP	Klahn
T-CIWVT-111583	Digital Design in Process Engineering - Oral Examination	3 CP	Klahn

Assessment
The learning control consists of:

1. Laboratory, ungraded according to SPO section 4 subsection 3.
2. Oral examination accfording to SPO section 4 subsection 2 No. 2.; duration about 30 minutes.

The laboratory is a prerequisite for the oral exam.

Prerequisites
None.

Competence Goal

- Understanding an applying the basics of 3D geometry modeling
- Identification of typical errors and artifacts in 3D models
- Selection of suitable methods for optimization, design and validation

Content
Digital design for Process Engineering introduces tools and methods for efficiently designing parts in process engineering.

- Computer Aided Design CAD (Autodesk Inventor)
- Topology optimization
- Parametric design and design automation (Grasshopper Rhino)
- Workflows of optimization, design and numerical validation

Module Grade Calculation
The module grade ist the grade of the oral exam.

Workload

- Lectures an Lab: 60 h
- Homework (CAD-design): 80 h
- Exam preparation: 40 h

Recommendations
The module is recommended as preparation for the modul Additive Manufacturing for Process Engineering [M-CIWVT-105407].

M 4.27 Module: Digitization in Particle Technology [M-CIWVT-104973]

Coordinators: Dr.-Ing. Marco Gleiß
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-CIWVT-110111	Digitization in Particle Technology	4 CP	Gleiß
T-CIWVT-114694	Digitization in Particle Technology - Project Work	2 CP	Gleiß

Assessment
Learning control consits of two components:

- Completed coursework (ungraded): Project presentation
- Oral examination lasting approx. 30 minutes.

Prerequisites
None.

Competence Goal
Capability to develop integrated strategies for the digitalization of processes in particle technology. This includes the development of methods but also the application of numerical methods.

The students work on the project as a team. The individual topics pick up on the context of the lecture. In addition to the subject-specific topics of the lecture, soft skills such as the ability to work in a team, independent planning and processing of a project and presentation skills are strengthened.

Content
Teaching methods for the systematic development of engineering-scientific digitization strategies for particle technology.

This includes multiscale modeling, the mathematical fundamentals of process modeling and simulation, model predictive control as well as basics of online and in-situ process analysis. Furthermore, the metrological acquisition of large amounts of data requires complex evaluation methods for further processing and reduction of the generated data. Machine learning methods can be used for this purposeThe developments in digitalization in particle technology are supported by various practical examples. In addition to the lecture a practical exercise in the form of a project work takes place.

Project work: Application of what has been learned to a new problem.

Module Grade Calculation
The Module grade is the grade of the oral examination.

Workload

- Lecture: 15 h, Exercise: 15 hrs
- Project work: 30 hrs
- Homework: 60 hrs
- Exam preparation: 60 hrs

M 4.28 Module: Dynamics of Process Engineering Systems [M-CIWVT-107037]

Coordinators: Dr.-Ing. Pascal Jerono
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-114105	Dynamics Process Engineering Systems - Prerequisite	3 CP	Jerono
T-CIWVT-114106	Dynamics of Process Engineering Systems - Exam	3 CP	Jerono

Assessment
The Learning control consists of two partial achievements:

1. Examination of another type.
2. Oral examination lasting approx. 45 minutes.

Module Grade Calculation
The module grade ist the CP-weighted average of the two partial achievements.

Literature

- P. Jerono und T. Meurer: Dynamik verfahrens-technischer Systeme, Vorlesungsskript.
- B. Brogliato, R. Lozano, B. Maschke, O. Egeland: Dissipative systems analysis and control, Springer, 2007.
- S. Strogatz: Nonlinear Dynamics and Chaos: with applications to physics, biology, chemistry, and engineering, Pereus Books.
- J. Hale, H. Kocak: Dynamics and Bifurcations, Springer.
- S. Wiggins: Introduction to Applied Nonlinear Systems and Chaos, Springer.
- S. Sastry: Nonlinear Systems: Analysis, Stability, and Control, Springer.
- S. Stephanopoulos: Chemical process control (Vol. 2), NJ: Prentice hall.

M 4.29 Module: Electrobiotechnology [M-CIWVT-106518]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: New Bio-Production Systems - Electro-Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	5	2

Mandatory			
T-CIWVT-113148	Electrobiotechnology	4 CP	Holtmann
T-CIWVT-113829	Electrobiotechnology Seminar	2 CP	Holtmann

M 4.30 Module: Electrocatalysis [M-ETIT-105883]

Coordinators: Prof. Dr. Ulrike Krewer
Dr. Philipp Röse

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: Specialization: New Bio-Production Systems - Electro-Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each summer term	1 term	English	4	3

Mandatory			
T-ETIT-111831	Electrocatalysis	5 CP	Röse

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

Prerequisites
none

Competence Goal
Students have a well-grounded knowledge of electrocatalytic energy technologies for the conversion and storage of electrical energy in chemicals (Power-to-X). They know the functional principle of state-of-the-art electrocatalysts in fuel cells and electrolysis and understand the underlying electrochemical and physical processes. Participation in the course enables the students to assess and understand the relationship between electrode structure and their selectivity, performance and stability. Furthermore, the students learn the theoretical basics of experimental methods that are relevant for the investigation of model electrodes and technical cells.

Content
Lecture:

- **Basics, concepts and definitions within the Power-to-X context:** Catalysis and electrocatalysis; activity and selectivity; fundamentals of electrochemical processes, elementary steps involving adsorbed intermediates.

- The role of intermediates: Electron transfer without intermediates, multi-electron transfer with intermediates; differences in adsorption energies of intermediates and active surfaces

- **Theoretical treatment of electron transfer reactions:** Tunneling processes at electrodes; electron transfer reactions (Marcus theory); role of electrode material on rate of electrode reaction.

- Measurement methods for the investigation of electrocatalytic reactions: Determination of the effective surface; Determination of the activity of electrochemically active species; Determination of the selectivity; Operando measurement methods

- Technically important electrocatalytic reactions and processes: The oxygen reduction reaction (ORR) and evolution reaction (OER); the chlorine evolution reaction.

Module Grade Calculation
The module grade is the grade of the written examination.

Workload
attendance in lectures: 30 * 45 min. = 22,5 h

attendance in exercises: 15 * 45 min. = 11,25 h

preparation and follow up of the lectures and practice: 76.25 hours (approx. 1.75 hours per lecture or exercise)

preparation of examination and attendance in examination: 40 h

A total of 150 h = 5 CR

Recommendations
The participation of the module "Electrochemical Energy Technologies" is helpful.

M 4.31 Module: Electrochemistry [M-CHEMBIO-106697]

Organisation: KIT Department of Chemistry and Biosciences
Part of: Specialization: New Bio-Production Systems - Electro-Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Irregular	1 term	German	4	1

Mandatory			
T-CHEMBIO-109773	Electrochemistry	3 CP	

Prerequisites
None

M 4.32 Module: Emulsification Technology [M-CIWVT-107439]

Coordinators: Dr.-Ing. Nico Leister
Dr.-Ing. Ulrike van der Schaaf

Organisation: KIT Department of Chemical and Process Engineering

Part of: Specialization: Food Process Engineering
Specialization: Design of Food Products

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-114611	Emulsification Technology	4 CP	Leister, van der Schaaf

Assessment
Learning control is an oral exam.

Prerequisites
None

Module Grade Calculation
The module grade ist the grade of the oral exam.

M 4.33 Module: Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics [M-MACH-107521]

Coordinators: apl. Prof. Dr. Alexander Nesterov-Müller
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-MACH-114731	Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics	4 CP	Nesterov-Müller

Assessment
see individual course

Prerequisites
None

Competence Goal
Understand the basics of peptide arrays
- Compare peptide arrays with classical molecular biology screening methods in terms of efficiency, scalability and specificity.
- Evaluate the advantages and limitations of different micropatterning and miniaturization methods.
Application of peptide arrays in biomedical research
- Identify key areas of application such as antibody profiling, epitope mapping and disease diagnostics.
- Analyze how peptide arrays are used in clinical and research applications.
Use AI and machine learning to analyze data
- Explain how machine learning techniques are used to analyze complex interaction data.
- Interpret high-throughput data from peptide arrays using computational methods.
Critically evaluate new developments and future perspectives
- Discuss the integration of adaptive AI into next-generation molecular arrays.
- Explore potential for expansion beyond peptides to multifunctional bioarrays in diagnostics and drug discovery.

Content
Outline:

Introduction to Peptide Arrays
The evolution of peptide arrays
Advantages over traditional screening methods
Fabrication of High-Density Peptide Arrays
Combinatorial synthesis techniques
Laser-based peptide transfer and micropatterning
Applications in Biomedical Research
Antibody profiling and serological analysis
Peptide arrays for epitope mapping and disease diagnostics
AI-Enhanced Data Analysis
Machine learning for pattern recognition in peptide interactions
Computational methods for high-throughput screening
Future Perspectives
Next-generation peptide arrays with adaptive AI integration
Beyond peptides: functionalized bioarrays for diagnostics and drug discovery

Module Grade Calculation
The module grade corresponds to the grade of the course component

Workload
Time of attendance: 15 * 1,5 h = 22,5 h
Preparation and follow up: 15 * 5,5 h = 82,5 h
Exam Preaparation and Exam: 15 h
Total: 120 h = 4 LP

Teaching and Learning Methods
Course lecture

Literature

- Lecture notes

- Sonnentag SJ, Jenne F, Orian-Rousseau V, Nesterov-Mueller A. High-throughput screening for cell binding and repulsion peptides on multifunctionalized surfaces. Commun Biol. 2024 Jul 17;7(1):870. doi: 10.1038/s42003-024-06541-7. PMID: 39020032; PMCID: PMC11255233.

- Jenne F, Berezkin I, Tempel F, Schmidt D, Popov R, Nesterov-Mueller A. Screening for Primordial RNA-Peptide Interactions Using High-Density Peptide Arrays. Life (Basel). 2023 Mar 15;13(3):796. doi: 10.3390/life13030796. PMID: 36983951; PMCID: PMC10053474.

- Schmidt, D., Gartner, P., Berezkin, I., Rudat, J., Bilger, M., Grünert, T., Zimmerer, N., Quarz, P., Scharfer, P., Brückel, J., Jung, A. P., Singh, P., Pooja, P., Meier, B., Stahlberger, M., Schabel, W., Bräse, S., Lanza, G., & Nesterov-Mueller, A. (2024). Selective Peptide Binders to the Perfluorinated Sulfonic Acid Ionomer Nafion. Advanced Functional Materials, 34(20), 2214932.

- Jenne F, Biniaminov S, Biniaminov N, Marquardt P, von Bojničić-Kninski C, Popov R, Seckinger A, Hose D, Nesterov-Mueller A. Resemblance-Ranking Peptide Library to Screen for Binders to Antibodies on a Peptidomic Scale. Int J Mol Sci. 2022 Mar 23;23(7):3515. doi: 10.3390/ijms23073515. PMID: 35408876; PMCID: PMC8999133.

M 4.34 Module: Extrusion Technology in Food Processing [M-CIWVT-105996]

Coordinators: PD Dr.-Ing. Azad Emin
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Food Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-CIWVT-112174	Extrusion Technology in Food Processing	4 CP	

Assessment
Learning control is an oral exam lasting about 20 minutes.

Prerequisites
None.

Competence Goal
Students will learn the fundamental principles of extrusion technology and its capabilities as well as the reasons behind its wide use by food industry. They will learn how various conventional food products are manufactured using this technology. Students will be able to approach a development of food more systematically by applying the principles of product design. They will also be able to combine and apply what they have learned in other courses/subjects during their studies in a multidisciplinary approach necessary for extruded food design. Students will understand how extrusion technology can be used in targeted ways to open up new opportunities for sustainable food transition.

Content
This course covers the principles of extrusion, the design of extrusion processes, and the formulation of extruded products. Moreover, the course gives an introduction to more fundamental topics such as biopolymer structure, reactivity, rheology and process control. In addition to the extrusion of conventional products, the design of sustainable and innovative food products such as plant-based meat and sea-food alternatives as well as upcycled food side-streams, will be discussed. While focusing on the fundamentals as well as on the state-of-the-art extrusion technology, the course is very practically oriented, and includes a practical demonstration of the principles learned.

Module Grade Calculation
The module grade ist the grade of the oral exam.

Additional Information
The course will take place as a block lecture in October 13 to 17. Registration required! Further information can be found in the course catalog.

Workload

- Attendance time: 30 h
- Self-study: 30 h
- Exam preparation: 60 h

Literature
Will be announced.

M 4.35 Module: Food Chemistry Basics [M-CHEMBIO-104620]

Coordinators: Prof. Dr. Mirko Bunzel
Organisation: KIT Department of Chemistry and Biosciences
Part of: Specialization: Design of Food Products

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CHEMBIO-109442	Food Chemistry Basics	4 CP	Bunzel

Prerequisites
None

Workload

- Lectures: 30 h
- Homework: 45 h
- exam preparation: 45 h

M 4.36 Module: Formulation of (Bio)pharmaceutical Therapeutics [M-CIWVT-104266]

Coordinators: Prof. Dr. Jürgen Hubbuch
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	5	1

Mandatory			
T-CIWVT-108805	Formulation of (Bio)pharmaceutical Therapeutics	4 CP	Hubbuch

Assessment
The examination is an oral examination with a duration of about 15 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

Competence Goal
The students will be able to discuss different development routes for the formulation of pharmaceuticals. The implications of different physiologies for the different formulations will be analyzed. Pro's and con's of different formulations and applications are evaluated.

Content
Fundamentals; Development of formulations for pharmaceuticals; Oral, Parenteral, Dermal, Nasal, Pulmonal; Formulation for Biopharmaceuticals

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload
Lectures: 30 h

Homework: 60 h

Exam preparation: 30 h

M 4.37 Module: Fundamentals of Water Quality [M-CIWVT-103438]

Coordinators: Dr. Michael Wagner
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-CIWVT-106838	Fundamentals of Water Quality	6 CP	Wagner

Assessment
Learning control is an oral exam lasting approx. 20 minutes.

Prerequisites
None

Competence Goal
Students can explain the relationships behind the occurrence of geogenic and anthropogenic compounds in the hydrological cycle. They are able to select adequate methods for the analysis of water constituents and microorganisms in water samples. They are familiar with the associated calculations, and they can compare and interpret the obtained data. They know how to apply different methods, how to analyze relationships and how to critically assess water quality analyses.

Content
Various types of water, legislations, analytical definitions, analytical quality, sampling methods, quick test methods, field investigations, organoleptic determinations, general investigations, optical characterization (turbidity, color, UV, Lambert-Beer`s law, photometry), titrations, acid-base-systems, buffering, main inorganic compounds (anions, cations, occurrence, ion chromatography, titration, complexometry, flame photometry, atomic spectroscopy), heavy metals and metalloids (occurrence and main methods for determination), organic compounds and organic micropollutants (occurrence, thin layer chromatography, high performance liquid chromatography, infrared spectroscopy, gas chromatography), water-specific sum parameters (DOC, AOX, COD, BOD), radioactivity, microbiology.

Module Grade Calculation
The module grade ist the grade of the oral exam.

Workload
Attendance time: 45 h
Preparation/follow-up: 65 h
Examination + exam preparation: 70 h

Literature

- Harris, D.C., 2010. Quantitative chemical analysis. W. H. Freeman and Company, New York.
- Crittenden, J.C. et al., 2005. Water treatment – Principles and design. Wiley & Sons, Hoboken.
- Patnaik, P., 2010. Handbook of environmental analysis: Chemical pollutants in air, water, soil, and solid wastes. CRC Press.
- Wilderer, P., 2011. Treatise on water science, four-volume set, 1st edition, volume 3: Aquatic chemistry and biology. Elsevier, Oxford.
- Leture notes in ILIAS

M 4.38 Module: Heat Exchangers [M-CIWVT-104371]

Coordinators: Prof. Dr.-Ing. Thomas Wetzel
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	5	3

Mandatory			
T-CIWVT-108937	Heat Exchangers	6 CP	Wetzel

Assessment
The examination is an oral examination lasting approx. 20 minutes.

Prerequisites
None

Competence Goal
Students know essential calculation methods for the dimensioning and verification of heat exchangers and are able to apply them to engineering problems, and implement them in calculation tools.

Content
types of heat exchangers, mean logarithmic temperature, efficiency-NTU-methodology, cell methodology, design of heat exchangers, heat transfer in typical heat exchanger geometries, Implementation of theoretical principles in calculation tools for heat exchangers

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 45 h
- Homework: 90 h
- Exam Preparation: 45 h

M 4.39 Module: Hydrogen and Fuel Cell Technologies [M-CIWVT-104296]

Coordinators: Prof. Dr.-Ing. Dimosthenis Trimis
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-CIWVT-108836	Hydrogen and Fuel Cell Technologies	4 CP	Trimis

Assessment
Learning control is an oral examination with a duration of about 20 minutes, SPO section 4, subsection 2.

Prerequisites
None

Competence Goal

- The students are able to identify similarities and differences between different fuel cell systems.
- The students are able to assess different fuel cell systems based on the thermodynamic fundamentals.
- Students can describe chemical and process fundamentals of fuel cell systems and, based on this, name conditions for their use.
- The students are able to name and assess hydrogen production processes.
- The students are able to identify and assess specific problem areas of hydrogen and fuel cell technology.

Content

- Introduction and thermo-dynamic basics
- PEM fuel cells
- Molten carbonate fuel cells (MCFC)
- Solid oxide fuel cells (SOFC)
- Fuel cells for liquid and solid fuels
- Hydrogen as an energy carrier
- Hydrogen production
- Electrolysis
- Steam reforming
- Partial oxidation
- Liquid fuel reforming process
- Conversion/purification of carbon monoxide
- Desulphurization
- Fuel cell systems: peripheral components and integration.

Module Grade Calculation
The module grade ist the grade of oral examination.

Workload
Attendance time: 30 h

Homework: 60 h

Exam Preparation: 30 h

Literature

- Ledjeff-Hey, K.; Mahlendorf, F.; Roes, J.: Brennstoffzellen; Entwicklung, Technologie, Anwendung. C. F. Müller Verlag GmbH, Heidelberg 2001; ISBN 3-7880-7629-1
- Na, Woon Ki: Fuel cells : modeling, control, and applications. CRC Press; Boca Raton u.a. 2010, ISBN 978-1-4200-7161-0
- Vielstich, W.; Lamm, A.; Gasteiger, H.A.: Handbook of Fuel Cells – Fundamentals, Technology and Applications. J. Wiley & Sons, Chichester UK, 2003, ISBN 0-471-49926-9
- Shekhawat, Spivey, Berry: Fuel cells: technologies for fuel processing. Elsevier, Amsterdam, 2011; ISBN 978-0-444-53563-4
- Hoogers, G (editor): Fuel Cell Technology Handbook. CRC Press, Boca Raton, London; 2003; ISBN: 0-8493-0877-1
- U.S. Department of Energy: Fuel Cell Handbook. 7th edition 2004. http://www.netl.doe.gov/File%20Library/research/coal/energy%20systems/fuel%20cells/FCHandbook7.pdf

M 4.40 Module: Industrial Aspects in Bioprocess Technology [M-CIWVT-105412]

Coordinators: Prof. Dr. Jürgen Hubbuch
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Biopharmaceutical Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-CIWVT-110935	Industrial Aspects in Bioprocess Technology	4 CP	Hubbuch

Assessment
The examination is an oral examination with a duration of about 15 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

Competence Goal
Students can discuss and analyze challenges and aspects in the biopharmaceutical industry.

Content

- Industrial Aspects on process development.

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Lectures: 30 h
- Homework: 60
- Exam preparation: 30

M 4.41 Module: Industrial Biocatalysis [M-CIWVT-106678]

Coordinators: PD Dr. Jens Rudat
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Industrial Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-CIWVT-113432	Industrial Biocatalysis	4 CP	Rudat

Assessment
The learning control is an oral examination llasting approx. 20 minutes.

Prerequisites
None

Competence Goal
Students are familiar with industrially significant applications of biocatalytic reactions, as well as their challenges and the fundamentals of the associated process control with isolated enzymes and whole cells. They are able to compare and critically evaluate processes leading to industrially relevant product (chemo- vs. biocatalysis and various biocatalytic options).

Content
Current developments of enzyme-catalyzed production as well as already established procedures:

- Pharma industries: synthesis and modification of drugs
- Chemical industries: synthesis and modification of basic and fine chemicals
- Food industries: production and enzymatic conversion of ingredients

In addition to the presentation of enzymatic reactions and their molecular-biological optimization, also aspects of process engineering are discussed such as choice and design of solvents/reaction media, downstream processing, as well as economic and ecologic factors.

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 30 hrs
- Homework: 45 hrs
- Exam Preparation: 45 hrs

Recommendations
Basic knowledge of biochemistry and enzyme technology is required.

Fundamentals:
Jaeger, Liese, Syldatk: Introduction to Enzyme Technology; SpringerSpektrum 2024; ISBN: Softcover 978-3-031-42998-9 eBook 978-3-031-42999-6
Als PDF frei herunterladbar auf der Seite des Verlags:
https://link.springer.com/book/10.1007/978-3-662-57619-9

Literature
Vorlesungsfolien und Übungsfragen (ILIAS), basierend auf aktuellen Veröffentlichungen in via KIT-Bibliotheksaccount frei verfügbaren biokatalytischen und multidisziplinären Fachzeitschriften, z. B.

- Trends in Biotechnology, Appl Microbiol Biotechnol, Green Chemistry, ChemSusChem, ChemCatChem
- Angew Chem Int Ed, Nature, Science, Chemical Reviews

Wer aus dem Bachelorstudium nicht über Grundkenntnisse in Biochemie und Enzymtechnik verfügt, sollte sich diese DRINGEND vorab aneignen anhand des Buches:

Jaeger, Liese, Syldatk: Introduction to Enzyme Technology; SpringerSpektrum 2024; ISBN: Softcover 978-3-031-42998-9; eBook 978-3-031-42999-6

Als PDF frei herunterladbar auf der Seite des Verlags: https://link.springer.com/book/10.1007/978-3-662-57619-9

Ältere Version auf Deutsch:

Jaeger, Liese, Syldatk: Einführung in die Enzymtechnologie; SpringerSpektrum 2018; ISBN: 978-3-662-57618-2

Als PDF frei herunterladbar auf der Seite des Verlags: https://link.springer.com/book/10.1007/978-3-662-57619-9

M 4.42 Module: Industrial Bioprocesses [M-CIWVT-106501]

Coordinators: Prof. Dr.-Ing. Michael-Helmut Kopf
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Industrial Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	5	1

Mandatory			
T-CIWVT-113120	Industrial Bioprocesses	4 CP	Kopf

Assessment
The examination is an oral examination with a duration of about 25 minutes.

Prerequisites
None

Competence Goal
The Students:

- get familiar with processes and techniques to develop industrial scale, biotech-based processes
- gain insight into the workflow of large scale (double-digit kt/a) industrial bioprocess development
- learn to combine theoretical understanding with practical applications related to relevant industrial systems.

understand relevance of tecno-economic evaluation as a basis for developing competitive processes

Content

- **Process to develop new or alternative, bio-based production process:**
  Ideation, Basic Concept, Critical analysis, Development steps
- **Value Proposition of novel product / process:**
  Quality, Performance, Price, Eco-efficiency, Regional aspects
- **Critical aspects along the development process:**
  Feedstock issues, Design to Cost, Specification and Performance, Regulatory Issues, Eco-efficiency (raw material and energy efficiency)
- **From Lab to Production (focus of lecture):**
  Phases of a development process: Explorative Research, Proof of Principle, Proof of Concept, Scale-up and Apparatus design, Plant design, Production
- **Competitor Intelligence**:
  Competitors with their “own” processes, Alternative products, similar in application
- **Benchmarking as a development tool:**
  Cost Benchmarking, CoP, as a development tool to identify optimization potential
- **Production scenarios:**
  Own investment, Toller, Production Partner

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 30 h
- Homework: 60 h
- Exam Preparation: 30 h

Literature
Skriptum zur Vorlesung

M 4.43 Module: Industrial Wastewater Treatment [M-CIWVT-105903]

Coordinators: Prof. Dr. Harald Horn
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	5	1

Mandatory			
T-CIWVT-111861	Industrial Wastewater Treatment	4 CP	Horn

Assessment
The learning control is an oral examination lasting approx. 20 minutes.

Prerequisites
None

Competence Goal
The students will be able to differentiate the composition of different types of industrial wastewater. Moreover, the students will have knowledge of treatment technologies, which can be applied to industrial wastewater. The students will be able to judge the biodegradability of industrial wastewater and can use that to design the needed treatment trains. The students do know treatment steps, which can be used enhance reuse the treated wastewater.

Content
This module provides the huge range of industrial wastewater composition for different industries (food, pulp and paper, chemical and pharmaceutical industry). The biodegradability will be analyzed and discussed with respect to potential treatment systems. A main focus will be biological treatment systems, especially biofilm reactors. Finally, the potential of water reuse in industrial processes will be discussed and solution will be provided.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload

- Attendance time: 30 h
- self-study: 60 h
- exam preparation: 30 h

Literature

- Horn, H. et al. (2017) Wastewater, 1. Introduction, Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA.
- Telgmann, L., et al. (2019) Wastewater, 2. Aerobic Biological Treatment. Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH Verlag GmbH & Co. KGaA.
- Rosenwinkel K.H. et al. (2020) Taschenbuch der Industrieabwasserreinigung, Vulcan Verlag.

M 4.44 Module: Innovation Management for Products & Processes in the Chemical Industry [M-CIWVT-104397]

Coordinators: Dr. Claudius Neumann
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Conversion of Renewable Resources

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-CIWVT-108980	Innovation Management for Products and Processes in the Chemical Industry	4 CP	Neumann

Assessment
Learning control is a written examination (multiple choice) lasting 60 minutes.

Prerequisites
None

Competence Goal
The students get to know the structures of the chemical industry.

They receive an insight into the interpretation of business figures and their connection with innovations.

They know how different factors influence innovation strategies.

They get to know the expiry of an innovation process.

The students have the opportunity to utilize the presented methods and tackle problems which are close to industrial application.

Besides the students receive an insight into the work of an innovation management (excursion).

Content
Background

The chemical industry had to adapt to the economic conditions of globalization during the last decades. It has been aligned to global markets thus changing the formerly scientific-technology oriented R&D. Today the work in industrial product & process development requires skills besides a thorough knowledge about chemistry and technology: a good general economic understanding combined with the competence to manage a complex system based on business figures. This competence allows scientifically and technology educated scientists and engineers to align chemical product and process development within the Innovation Strategy to the strategic business plan. It is implemented within the Innovation Process and monitored and managed by characteristic performance indicators. Thus, the economic benefit of innovation can be quantified using quantitative measures.

Scope of the lecture

The lecture intends to provide the fundamentals for understanding Innovation Management and to utilize them by tackling examples close to industrial application. The course addresses the following key questions:

What are the structures in the chemical industry?

What are business figures? How are they interpreted and applied in terms of innovation?

What are customers? How do they influence innovation?

How do marketing and product management determine innovation?

What is a business strategy? How is it connected to the innovation strategy?

What is the Innovation Process? How is it managed?

What is Innovation Portfolio Management? Why is it needed for successful innovation?

What are state of the art Innovation Management practices in the chemical industry?

Visit

The lecture includes a one day visit to the Evonik Site Hanau for experiencing current Innovation Management practices from discussions with managers in the chemical industry.

Module Grade Calculation
The module grade ist the gradeof the written exam.

Workload

- Attendance time (Lecture): 30 h (Block lectures 4 days)
- Homework: 60 h
- Exam Preparation: 30 h

M 4.45 Module: Internship [M-CIWVT-107422]

Coordinators: Dr.-Ing. Siegfried Bajohr
Dr.-Ing. Barbara Freudig
Organisation: KIT Department of Chemical and Process Engineering
Part of: Internship

Credits	Grading	Recurrence	Duration	Language	Level	Version
12 CP	pass/fail	Each term	1 term	German	4	1

Mandatory			
T-CIWVT-114573	Internship	12 CP	Bajohr, Freudig

Workload
12 weeks, at least 360 hrs.

M 4.46 Module: Introduction to Numerical Simulation of Reacting Flows [M-CIWVT-106676]

Coordinators: Prof. Dr. Oliver Thomas Stein
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each winter term	1 term	English	5	1

Mandatory			
T-CIWVT-113435	Introduction to Numerical Simulation of Reacting Flows - Prerequisite	5 CP	Stein
T-CIWVT-113436	Introduction to Numerical Simulation of Reacting Flows	3 CP	Stein

Assessment
The learning control consists of two partial achievements:

1. Completed Coursework: As a prerequisite for the oral exam, reports on the tutorial have to be submitted. These document the processed task, the generated data and their analysis.
2. Oral examination lasting approx. 30 minutes.

Prerequisites
None

Competence Goal
Course participants know the fundamentals of both batch and flow reactors for the simulation of chemical kinetics and reacting flows. They are knowledgeable of numerical methods for temporal and spatial discretisation. In the related Python tutorials, they have obtained a first practical experience in setting up, running and post-processing chemical kinetics and reacting flow simulations, forming the basis for more advanced simulations.

Content

- Introduction to Python
- batch reactors for chemical kinetics simulations
- simple flow reactors
- Newton-Raphson method
- time and space discretisation

Module Grade Calculation
The module grade ist the grade of the oral exam.

Additional Information
The Python tutorials will be conducted on the students' laptops.

Workload

- Attendance time
  Lectures 2 SWS: 30 hrs
  Tutorials 2 SWS: 30 hrs
- Self-study
  Preparation and wrap-up lectures: 15 hrs
  Data analysis, preparation and submission of reports: 105 hrs
- Exam preparation:
  60 hrs

M 4.47 Module: Introduction to Sensory Analysis [M-CIWVT-105933]

Coordinators: Dr. Heike Hofsäß
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Design of Food Products

Credits	Grading	Recurrence	Duration	Language	Level	Version
2 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-109128	Introduction to Sensory Analysis with Practice	2 CP	Hofsäß

M 4.48 Module: Journal Club - Novel Bioproduction Systems [M-CIWVT-106526]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: Interdisciplinary Qualifications

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	5	1

Mandatory			
T-CIWVT-113149	Journal Club - Novel Bioproduction Systems	4 CP	Holtmann

M 4.49 Module: Kinetics and Catalysis [M-CIWVT-104383]

Coordinators: Prof. Dr.-Ing. Gregor Wehinger
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-106032	Kinetics and Catalysis	6 CP	Wehinger

Assessment
Learning control is a written examination lasting 60 minutes.

Prerequisites
None

Competence Goal
Students are introduced to the kinetics of molecular transport and reaction. They learn about catalysis as a kinetic phenomenon. They are able to analyze and interpret the kinetics of homogeneously, enzymatically and heterogeneously catalyzed processes.

Content
Kinetic theory of gases; molecular transport in gases and liquids; diffusivity in porous solids; molecular interactions and Lennard-Jones potential; kinetics of homogeneous reactions; adsorption at solid surfaces and sorption kinetics; elements of the kinetics of catalyzed reactions (homogeneous acid-base, enzymatic and heterogeneous catalysis).

Module Grade Calculation
The module grade ist the grade of the written exam.

Workload

- Attendance time (Lecture): 42 h
- Revision course: 28 h
- Homework: 80 h
- Exam Preparation: 30 h

Literature

- W. Atkins: Physical Chemistry (Oxford University Press, 1998);
- B. Bird, W.E. Stewart, E.N. Lightfoot: Transport Phenomena (Wiley, 2007)
- C. Gates: Catalytic Chemistry (Wiley, 1992)
- Ertl: Reactions at Solid Surfaces (Wiley, 2009)

M 4.50 Module: Materials and Processes for Electrochemical Storage [M-CIWVT-104353]

Coordinators: Prof. Dr. Jens Tübke
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each term	1 term	German	5	2

Mandatory			
T-CIWVT-108146	Materials and Processes for Electrochemical Storage	4 CP	Tübke

Assessment
The examination is an oral examination with a duration about 30 minutes.

Prerequisites
None

Competence Goal
The students know how electrochemical storage devices and converters (batteries and fuel cells) work and the basic electrochemical principles required for this. They are familiar with active and passive materials used, know how these can be manufactured and, if necessary, modified. They will be familiar with process engineering methods for the manufacture of battery cells and fuel cell stacks and know how overall systems are constructed.

Content
Electrochemical basics

Basic introduction to electrochemistry, electrochemical potentials, concentration dependence, electrochemical methods.

Basics of electrochemical storage systems and fuel cells.

Structure and operation of primary and secondary batteries:
Alkali-manganese, zinc-carbon, lead-acid, zinc-air, nickel-cadmium, nickel-metal hydride, redox-flow batteries, high-temperature batteries, lithium (sodium)-ion batteries, lithium-sulfur batteries, solid-state batteries.

Design and operation of fuel cells:
PEMFC, AMFC, DMFC, SOFC, MCFC.

Materials and processes for electrochemical storage systems

Intercalation and conversion electrodes, liquid, polymeric and ceramic separators (electrolytes),
Electrolyte additives and electrode coatings,
current collector materials (metals, modified plastics), housing materials
catalyst and membrane materials for fuel cells, stack design and materials used in fuel cells

Production methods and processes for manufacturing battery cells and fuel cell stacks

Design principles and production processes for water-based battery systems (lead-acid, nickel-metal hydride)
Design principles and production processes for lithium-based battery systems and solid-state batteries,
Electrode production (paste production, coating process, drying process), dry coating process,
Production processes for separation foils for different battery systems
Quality assurance processes in cell production, cell forming and testing processes for cells
Manufacturing processes for stack components for fuel cells

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 30 h
- Homework: 80 h
- Exam Preparation: 10 h

M 4.51 Module: Membrane Technologies in Water Treatment [M-CIWVT-105380]

Coordinators: Prof. Dr. Harald Horn
Dr.-Ing. Florencia Saravia
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	5	3

Mandatory			
T-CIWVT-113235	Excercises: Membrane Technologies	1 CP	Horn, Saravia
T-CIWVT-113236	Membrane Technologies in Water Treatment	5 CP	Horn, Saravia

Assessment
The learning control consists of two partial achievements:

- written examination lasting 90 minutes
- completed coursework (prerequisite for the written exam):
  Submission of exercises, membrane design and short presentation (5 minutes, group work).

Prerequisites
None

Competence Goal
Students have a fundamental knowledge on membrane technology in water and waste water treatment. They learn how the different membrane systems (reverse osmosis, nanofiltration, ultrafiltration, microfiltration, and dialysis) have to be applied to produce a certain water quality. They are able to design such systems.

Content

- The solution-diffusion model
- Concentration polarization and the consequences for membrane module design.
- Membrane production and properties.
- Membrane configuration and design
- Membrane systems for desalination and brackish water treatment
- Membrane bio reactors for waste water treatment
- Biofouling, scaling and prevention of both
- Excursions with introduction

Module Grade Calculation
The module grade is the grade of the written examination.

Workload

- Attendance time: Lectures: 30 hrs; Exercises/ excursions: 15 hrs
- Preparation/follow-up: 60 hrs
- Examination + exam preparation: 75 hrs

Recommendations
Module „Water Technology (PA221)“

Literature

- Melin, T., Rautenbach, R., 2007. Membranverfahren - Grundlagen der Modul- und Anlagenauslegung. Springer Verlag Berlin Heidelberg.
- Mulder, M.H., 2000. Basic Principles of Membrane Technology. Kluwer Academic, Dordrecht.
- Schäfer, I. A., Fane, A. G. (Eds., 2021): Nanofiltration: Principles and Applications., 2. Edition, Elsevier, Oxford.
- Staude, E., 1992. Membranen und Membranprozesse. Verlag Chemie, Weinheim.
- Vorlesungsunterlagen in ILIAS

M 4.52 Module: Microfluidics [M-CIWVT-104350]

Coordinators: PD Dr. Gero Leneweit
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	3

Mandatory			
T-CIWVT-108909	Microfluidics	4 CP	Leneweit

Assessment
The examination is an oral examination with a duration of about 30 minutes.

Prerequisites
None

Competence Goal
Acquisition of capacities for the development of microfluidic systems and their investigation

Content

- physics an measurement technology of miniaturization, scales in micro and nanofluicics
- introduction to fabrication methods fo chemical-biological process technologies
- Micro- and nanofluidic flow processes
- Electrohydrodynamics of microsystems: electroosmosis and electrophoresis
- Microfluidic sequencing techniques for genomics and proteomics
- Manipulation processes for the metabolomics of single cells
- Diffusion, mixing, and separation in microsystems
- Digital microfluidics and operators of microfluidic process control
- Generation and analysis of technological multiphase systems
- Industrial applications of microfluidics
- Microfluidic production of drug delivery systems for biologics
- Microfluidic process technologies and scale-up for biotechnology

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 30 h
- Homework: 60 h
- Exam Preparation: 30 h

Literature
Skriptum zur Vorlesung

M 4.53 Module: Microfluidics Lab [M-CIWVT-107433]

Coordinators: PD Dr. Gero Leneweit
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
2 CP	pass/fail	Each winter term	1 term	German	5	1

Mandatory			
T-CIWVT-110549	Microfluidics - Case Studies	2 CP	Leneweit

Assessment
Completed coursework.

Prerequisites
None

Content
Lab experiments:Preparation of nanoemulsions from aerosols in a micromixer; preparation and characterization of nanocapsules as drug delivery systems by nanofluidics.

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload
60 hrs

M 4.54 Module: Microsystems in Bioprocess Engineering [M-CIWVT-107424]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	2

Mandatory			
T-CIWVT-114600	Microsystems in Bioprocess Engineering	4 CP	Grünberger

Assessment
Learning control is an oral exam lasting approx. 30 minutes.

Module Grade Calculation
The module grade ist the grade of the oral exam.

M 4.55 Module: Mixing, Stirring, Agglomeration [M-CIWVT-105399]

Coordinators: Dr.-Ing. Frank Rhein
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering
Specialization: Biopharmaceutical Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-CIWVT-110895	Mixing, Stirring, Agglomeration	6 CP	Rhein

Assessment
Learning control is an oral individual examination with a duration of 30min according SPO section 4, subsection 2.

Prerequisites
None

Competence Goal
The students are able to explain the fundamental laws and the derived physical principles of mixing, stirring and the particle agglomeration and not only to relate them to the principally suited processes but also to selected apparatuses. They have the ability to apply the relationship between product, operation and design parameters to different processes. They can analyse the related process engineering problems with scientific methods and give alternative problem solution proposals. On the basis of their skills they can evaluate whether and if applicable a promising process can be designed.

Content

- Fundamentals and applications
- statistic methods to characterize the mixing quality
- characterisation of the flow properties of bulk solids and liquids
- introduction into dimension analysis to achieve characteristic numbers important for mixing problems
- scale-up procedures for specific mixing processes
- solids mixing processes like free-fall, pusher and intensive mixers, fluidised bed, air jet, and turnover mixers; pile mixing techniques
- fluid-mixing processes like homogenisation, suspending, emulsifying, gassing and heat transfer
- static mixers and kneaders
- adhesion forces between particles
- agglomerate properties: characterisation of agglomerates regarding size, size distribution, porosity, density, stability, flow behaviour and instantiation behavior
- agglomeration processes like roll-agglomeration, mixing agglomeration, fluidized bed and spray agglomeration, agglomeration in liquids by means of coagulation, flocculation or changed wettability, press agglomeration by means of tabletting, roller compaction or extrusion and post hardening of agglomerates by means of sintering
- Introduction to modeling and simulation of mixing and agglomeration processes

Module Grade Calculation
The module grade ist the grade of oral examination.

Workload
Lectures: 3 SWS/ 45 h
Homework: 75 h
Exam preparation: 60 h

Total: 180 h

M 4.56 Module: Modeling Physiological Systems [M-ETIT-106782]

Coordinators: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-ETIT-113630	Modeling Physiological Systems	6 CP	Loewe
T-ETIT-114690	Modeling Physiological Systems - Workshop	0 CP	Loewe

Assessment

- The examination takes place in form of a written examination lasting 90 min.
- The submission of three ungraded workshop tasks before the exam is mandatory.

Prerequisites
none

Competence Goal
The students will be able to

- Describe physiological functional principles of selected organs
- Formalize physiological relationships using engineering methods (e.g. mathematical equations, standardized diagram forms, etc.)
- Implement these models with adequate numerical schemes
- Apply formalized models to develop a deeper understanding of physiological relationships; e.g. by means of simulation studies
- Describe pathomechanisms of selected diseases
- Characterize selected pathologies qualitatively and quantitatively by using physiological models

Content
The module provides knowledge and methods for modeling physiological processes and pathomechanisms. Physiological functional principles are described using the example of 2-3 organ systems and then implemented in mathematical-technical models. The model types of ordinary differential equations, electrical equivalent circuits and control loops are taken up and deepened in practical tasks. The course is deepened both fundamentally by working on theoretical tasks with pen and paper as well as through programming and simulation studies.

At least one clinical picture is introduced for each example organ system and examined using modeling and simulation.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload
Attendance in lectures and exercises: 22*2h = 44h

Preparation / follow-up: 22*2h = 44h

Preparation of and attendance in examination: 40h

Programming exercises 20h+15h+17h= 52h

A total of 180 h = 6 CR

Recommendations
Basic knowledge of

- ordinary differential equations
- system dynamics and control engineering
- programming in a scripting language (e.g. Python, Matlab)
- human anatomy & physiology

M 4.57 Module: Module Master's Thesis [M-CIWVT-107323]

Coordinators: Prof. Dr. Reinhard Rauch
Organisation: KIT Department of Chemical and Process Engineering
University
Part of: Master's Thesis

Credits	Grading	Recurrence	Duration	Language	Level	Version
30 CP	graded	Each term	1 term	German/English	4	1

Mandatory			
T-CIWVT-114397	Master's Thesis	30 CP	Rauch

Prerequisites
SPO section §14 (1)

The prerequisite for admission to the Master's thesis module is that the student has successfully completed module examinations amounting to 60 CP including the internship in accordance with § 14 a

Modeled Prerequisites
The following conditions have to be fulfilled:

1. You need to have earned at least 60 credits in your study program.
2. The field Internship must have been passed.

M 4.58 Module: Molecular Biology and Genetics (BM-4C_ETIT) [M-CHEMBIO-106204]

Coordinators: Prof. Dr. Jörg Kämper
Prof. Dr. Natalia Requena Sanchez
Organisation: KIT Department of Chemistry and Biosciences
Part of: Specialization: New Bio-Production Systems - Electro-Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
5 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CHEMBIO-103675	Molecular Biology and Genetics	5 CP	Kämper, Requena Sanchez

Assessment
Written exam of 120 minutes on the contents of the lecture parts Molecular Biology (3 LP) and Genetics (2 LP) (Total 5LP)

Prerequisites
none

Competence Goal
Students deepen their knowledge of the molecular basis of life and the technical possibilities of manipulating living organisms by altering their genes or their expression. This includes
a deeper theoretical understanding of the following areas:
Microbiology,Genetics, Molecular Biology

Content
VL Genetics:

DNA, DNA structure, DNA topology, chromosomes, chromatin, DNA replication, mutations, repair, transposable elements, assembly of genes, transcription, RNA processing, regulation of gene expression in pro- and eukaryotes (transcriptional, posttranscriptional, posttranslational), protein synthesis, epigenetics: Methylation, histone modifications, Hu-man genetics, tumor genetics, genome projects, functional genomics/proteomics/bioinformatics, immunogenetics (introduction), developmental genetics (introduction), behavioral genetics (introduction).

VL Molecular Biology:

Molecular Biology Introduction, DNA extraction, restriction enzymes, cloning in vectors, library screening, bioinformatics, sequencing, genome sequencing, RNA, Northern blot, RT-PCR, Real time PCR, cDNA library, microarrays, recombinant proteins, western blot, affinity chromatography, mutagenesis, transformation.

Module Grade Calculation
The module grade is the grade of the written exam

Workload
Attendance time: 75 h
Follow-up and exam preparation: 75 h
Total: 150 h
5 LP

Teaching and Learning Methods
Lectures

Literature
VL Genetics:

Content of the lecture in keywords

Textbooks of genetics, e.g. Knippers, Molecular Genetics, 9th edition; Watson, Molecular Biology of the Gene, 5th edition; Griffiths, Introduction to Genetic Analysis, 9th edition.

VL Molecular Biology:

Textbooks of molecular biology, e.g., Molecular Cell Biology-Lodish (Spektrum), Watson Molecular Biology (Pearson).

M 4.59 Module: NMR for Engineers [M-CIWVT-104401]

Coordinators: apl. Prof. Dr. Gisela Guthausen
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-108984	NMR for Engineers	4 CP	Guthausen
T-CIWVT-109144	Laboratory Work for NMR for Engineers	2 CP	Guthausen

Prerequisites
None

Competence Goal
Knowledge about NMR and their applications, basic understanding of the phenomena

Content
An overview of applications of nuclear magnetic resonance (NMR) will be given together with the basic description of this analytical tool. In the focus of the lectures are typical applications of NMR in chemical and bio engineering. The understanding of this versatile analytical method will be developed on the basis of dedicated examples.

Workload

- Attendance time (Lecture): 30 h
- Revision course: 30 h
- Internship: Atendance Time 30 h, Preparation Time 30 h
- Exam Preparation: 60 h

Literature
Lehrbücher Kimmich und Callaghan, weitere Literatur wird jeweils in der Vorlesung angegeben.

M 4.60 Module: NMR Methods for Product and Process Analysis [M-CIWVT-105890]

Coordinators: apl. Prof. Dr. Gisela Guthausen
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German/English	4	1

Mandatory			
T-CIWVT-111843	NMR Methods for Product and Process Analysis	4 CP	Guthausen

Prerequisites
None

Competence Goal
Knowledge about NMR and their applications, basic understanding of the phenomena.

Content
An overview of applications of nuclear magnetic resonance (NMR) will be given together with the basic description of this analytical tool. In the focus of the lectures are typical applications of NMR in chemical and bio engineering. The understanding of this versatile analytical method will be developed on the basis of dedicated examples.

Module Grade Calculation
The module grade ist the grade of the oral examination.

Workload

- Attendance time (Lecture): 30 h
- Revision course: 30 h
- Exam Preparation: 60 h

Literature
Lehrbücher Kimmich und Callaghan, weitere Literatur wird jeweils in der Vorlesung angegeben.

M 4.61 Module: Nonlinear Process Control [M-CIWVT-106316]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German/English	5	1

Mandatory			
T-CIWVT-112824	Nonlinear Process Control	6 CP	Meurer

Assessment
Learning control is an oral examination with a duration of about 45 minutes.

Prerequisites
None

Competence Goal
Students will gain an in-depth understanding of methods and concepts for analyzing and controlling nonlinear dynamic systems. They will understand the underlying mathematical concepts and be able to apply them to new problems. They will gain a comprehensive understanding of nonlinear control concepts and be able to apply these methods independently to specific problems, both analytically and with the aid of computer algebra systems.

Content
Nonlinearities are ubiquitous in nature. Differing from linear control theory and linear control systems, which typically rely on the local linearization of a nonlinear system around some equilibrium, this module addresses nonlinear concepts for the analysis and the control of nonlinear systems. The course covers the following topics:

- Introduction to the dynamic analysis of nonlinear systems
- Differential geometric concepts
- Exact feedback linearization
- Differential flatness and flatness-based feedforward and tracking control
- Lyapunov theory and Lyapunov-based design methods

Problem sets are considered in the exercises to apply the developed methods using analytical tools as well as computer algebra systems to realize the design approaches.

Module Grade Calculation
The grade of the module is the grade of the oral exam.

Additional Information
If required, the course will be offered in English.

Workload
Attendance time: Lectures: 30 hrs. Exercises: 15 hrs.

Self-study: 75 hrs.

Exam preparation: 60 hrs.

Literature

- T. Meurer: Nonlinear Process Control, Lecture Notes.
- B. Brogliato, R. Lozano, B. Maschke, O. Egeland: Dissipative systems analysis and control, Springer, 2007.
- H. Nijmeijer, A.J. van der Schaft: Nonlinear Dynamical Control Systems. Springer, 1991.
- Isidori: Nonlinear Control Systems. Springer-Verlag, 1995.
- H. K. Khalil: Nonlinear Systems, Prentice Hall, 2002.
- M. Krstic, I. Kanellakopoulos, P. Kokotovic: Nonlinear and Adaptive Control Design, John Wiley & Sons, 1995.
- S. Sastry: Nonlinear Systems, Analysis, Stability, Control. Springer-Verlag, 1999.
- A. J. van der Schaft: L2-gain and passivity techniques in nonlinear control, Springer, 2016.
- M. Vidyasagar: Nonlinear Systems Analysis, SIAM, 2002.

M 4.62 Module: Numerical Simulation of Reacting Multiphase Flows [M-CIWVT-107076]

Coordinators: Prof. Dr. Oliver Thomas Stein
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each summer term	1 term	German/English	5	1

Mandatory			
T-CIWVT-114117	Numerical Simulation of Reacting Multiphase Flows - Prerequisite	5 CP	Stein
T-CIWVT-114118	Numerical Simulation of Reacting Multiphase Flows	3 CP	Stein

Assessment
The learning control consists of two partial achievements:

1. Completed Coursework: As a prerequisite for the oral exam, reports on the tutorial have to be submitted. These document the processed task, the generated data and their analysis.
2. Oral examination lasting approx. 30 minutes.

Prerequisites
The completed coursework is a prerequisite for participation in the oral examination.

Competence Goal
Course participants can explain basic and advanced concepts related to the modelling and simulation of reacting multiphase flows. They are knowledgeable of the governing equations of both single and multiphase flows and can describe the physical meaning of all terms in these equations. They can explain the fundamentals of turbulence and turbulence modelling, chemical conversion and multiphase flow modelling. They are knowledgeable of numerical approximation and solution methods for reacting multiphase flows and know how to apply them. In the related tutorials with the OpenFOAM software, they have obtained a first practical experience in setting up, running and analysing their simulations and are capable of applying the obtained knowledge to further simulation tasks.

Content

- Basics of computational fluid dynamics
- Governing equations, turbulence & turbulence modelling
- Chemical conversion and reacting flows
- Non-reacting and reacting multiphase flows
- Numerical approximation and solution methods

Module Grade Calculation
The module grade ist the grade of the oral exam.

Additional Information
The OpenFOAM tutorials will be conducted on the students' laptops. All course material is provided in English, while the lecture will be held in German or English, as required.

Workload

- Attendance time
  Lectures 2 SWS: 30 h
  Tutorials 2 SWS: 30 h
- Self-study
  Preparation and wrap-up lectures: 15 h
  Data analysis, preparation and submission of reports: 105 h
- Exam preparation:
  60 h

Literature
Will be announced.

M 4.63 Module: Optimal and Model Predictive Control [M-CIWVT-106317]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	English	5	1

Mandatory			
T-CIWVT-112825	Optimal and Model Predictive Control	6 CP	Meurer

Assessment
Learning control is an oral examination with a duration of about 45 minutes.

Prerequisites
none

Competence Goal
Students will gain an in-depth understanding of dynamic optimization with constraints, optimal control, and model predictive control. They will understand the underlying mathematical concepts and be able to apply them to new problems. They will gain a comprehensive understanding of optimization methods and be able to apply these methods independently to dynamic optimization problems. Students are familiar with various numerical solution approaches, understand how they work, and can implement them for optimization problems.

Content
Many problems in industry and economy rely on the determination of an optimal solution satisfying desired performance criteria and constraints. In mathematical terms this leads to the formulation of an optimization problem. Here it is in general distinguished between static and dynamic optimization with the latter involving a dynamical process. This lecture gives an introduction to the mathematical analysis and numerical solution of dynamic optimization problems with a particular focus on optimal control and model predictive control. The lecture addresses the following topics:

- Fundamentals of dynamic optimization problems
- Dynamic optimization without and with constraints
- Linear and nonlinear model predictive control
- Numerical methods

Selected examples are considered and solved in the exercises and dedicated computer exercises.

Module Grade Calculation
The grade of the module is the grade of the oral exam.

Workload
Attendance time: Lectures: 30 hrs. Exercises: 15 hrs.

Self-study: 60 hrs.

Exam preparation: 75 hrs.

Literature

- T. Meurer: Optimal and Model Predictive Control, Lecture Notes.
- D. G. Luenberger, Y. Ye: Linear and Nonlinear Programming, Springer, 2008.
- J. Nocedal, S.J. Wright: Numerical Optimization, Springer, 2006.
- M. Papageorgiou, M. Leibold, M. Buss: Optimierung, Springer, 2012.
- E. Camacho, C. Alba: Model Predictive Control, Springer, 2004
- L. Grüne, J. Pannek: Nonlinear Model Predictive Control: Theory and Algorithms, Springer, 2011.
- L. Wang: Model Predictive Control System Design and Implementation Using MATLAB, Springer, 2009.

M 4.64 Module: Organ Support Systems [M-MACH-102702]

Coordinators: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-MACH-105228	Organ Support Systems	4 CP	Pylatiuk

Assessment
A performance assessment is held in form of a written examination of 60 minutes.

Prerequisites
none

Competence Goal
Students have comprehensive knowledge of the functioning of support systems and their components (e.g. sensors, actuators) for different human organs (e.g. heart, kidney, liver, eye, ear, locomotor system). They know the physical basics, the technical solutions and the essential aspects of these medical technology systems and their current limitations. Furthermore, they know bioreactors and other methods of using the body's own cells to support organs (tissue engineering). Furthermore, they have comprehensive knowledge of organ transplantation and its limitations.

Content
Hemodialysis, liver dialysis, heart-lung machine, artificial hearts, biomaterials, definition and classification of organ support and organ replacement, hearing prostheses, visual prostheses, exoskeletons, neuroprostheses, endoprostheses, tissue engineering.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload

1. Attendance time Lecture: 15 * 2h = 30h
2. Pre- and postprocessing time Lecture: 15 * 3h= 45h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendations
The content of module MMACH-105235 complements this lecture.

Literature

- Jürgen Werner: Kooperative und autonome Systeme der Medizintechnik: Funktionswiederherstellung und Organersatz. Oldenbourg Verlag.
- Rüdiger Kramme: Medizintechnik: Verfahren - Systeme – Informationsverarbeitung. Springer Verlag.
- E. Wintermantel, Suk-Woo Ha: Medizintechnik. Springer Verlag.

M 4.65 Module: Parallel Computing [M-MATH-101338]

Coordinators: PD Dr. Mathias Krause
Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Level	Version
5 CP	graded	Irregular	1 term	5	1

Mandatory			
T-MATH-102271	Parallel Computing	5 CP	Krause, Wieners

Prerequisites
None

M 4.66 Module: Particle Technology [M-CIWVT-104378]

Coordinators: Prof. Dr.-Ing. Achim Dittler
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-106028	Particle Technology Exam	6 CP	Dittler

Assessment
Learning control is a written examination lasting 120 minutes.

Prerequisites
None

Competence Goal
Students develop an advanced understanding of properties & behavior of particles and particulate systems in important engineering applications; they are able to use this understanding for calculations and design of selected processes

Content
Description and behavior of particles and particulate systems in engineering applications; selected unit operations in particle technology.

Module Grade Calculation
The module grade ist the grade of the written exam.

Workload

- Attendance time (Lecture): 45 h
- Homework: 90 h
- Exam Preparation: 45 h

M 4.67 Module: Plant and System Design [M-CIWVT-107402]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Industrial Biotechnology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each term	1 term	German	4	1

Mandatory			
T-CIWVT-114537	Plant an System Design	6 CP	Grünberger, Holtmann

M 4.68 Module: Practical Course in Water Technology [M-CIWVT-103440]

Coordinators: Dr. Andrea Hille-Reichel
Prof. Dr. Harald Horn
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	3

Mandatory			
T-CIWVT-106840	Practical Course in Water Technology	3 CP	Hille-Reichel, Horn
T-CIWVT-110866	Excursions: Water Supply	1 CP	Horn

Assessment
The learning control consists of:

- Laboratory: 6 Experiments including entrance test, protocol; presentation about a selected experiment (about 15 minutes); final test
- Excursions, protocols about excursions (ungraded)

Prerequisites
The module can only be taken in combination with the *Water Technology* module.
Participation in the lab course is possible after participating in the excursion.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module M-CIWVT-103407 - Water Technology must have been started.

Competence Goal
Students can explain the most important processes in water treatment. They are able to do calculations, and to compare and interpret data. They learn how to use different methods, and to interpret different processes.

Content
6 different experiments out of: equilibrium study of the calcium carbonate system, flocculation, adsorption, oxidation, atomic absorption spectroscopy, ion chromatography, liquid chromatography, sum parameter, and an oral presentation of the student. In addition, excursions to two different treatment plants (waste water, drinking water).

Module Grade Calculation
Module grade is the grade of the laboratory and is formed as follows:

A total of 150 points can be achieved:

- maximum 60 points for the experiments (10 each)
- maximum 15 points for the presentation
- maximum 75 points for the final certificate

At least 80 points must be achieved in order to pass.

Workload
Attendance time: Introduction and presentation (4 h), 6 Experiments (4 h each), 2 excursions: 36 h
Preparation/follow-up, protocols, presentation: 50 h
Examination + exam preparation: 34 h

Literature

- Harris, D. C., Lucy, C. A. (2019): . Quantitative chemical analysis, 10. edition. W. H. Freeman and Company, New York.
- Crittenden, J. C. et al. (2012): Water treatment – Principles and design. Wiley & Sons, Hoboken.
- Patnaik, P., 2017: Handbook of environmental analysis: Chemical pollutants in air, water, soil, and solid wastes. CRC Press.
- Wilderer, P. (Ed., 2011): Treatise on water science, four-volume set, 1st edition, volume 3: Aquatic chemistry and biology. Elsevier, Oxford.
- Vorlesungsskript im ILIAS
- Praktikumsskript

M 4.69 Module: Principles of Constrained Static Optimization [M-CIWVT-106313]

Coordinators: Dr.-Ing. Pascal Jerono
Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	5	1

Mandatory			
T-CIWVT-112811	Principles of Constrained Static Optimization	4 CP	Jerono, Meurer

Assessment
Learning control is an oral exam with a duration of about 45 minutes.

Prerequisites
None

Competence Goal
Students have an in-depth understanding of static optimization with constraints. They understand the underlying mathematical concepts and can apply them to new problems. They have a comprehensive understanding of optimization methods and are able to apply these methods independently to static optimization problems. Students are familiar with various numerical solution approaches, understand how they work, and can implement them for optimization problems.

Content
Optimization problems arise in a broad variety in different scientific and engineering domains ranging from the fit of parameter based on a performance criterion to finding extreme values of an objective function and further extending to machine learning applications. While dynamic optimization (addressed on the module M-CIWVT-106317) involves dynamical systems in static optimization the minimization (maximization) of functions subject to equality and inequality constraints is considered. This module gives an introduction to the mathematical analysis and numerical solution of unconstrained and constrained static optimization problems. The lecture addresses the following topics:

- Fundamentals of static optimization problems
- Unconstrained static optimization
- Constrained static optimization
- Numerical methods

Selected examples are considered and solved in the exercises and dedicated computer exercises.

Module Grade Calculation
The grade of the module ist the grade of the oral exam.

Workload
Attendance time: Lectures: 15 hrs. exercises: 15 hrs.

Self-study: 50 hrs.

Exam praparation: 40 hrs.

Literature

- T. Meurer: Optimal and Model Predictive Control, Lecture Notes.
- D. G. Luenberger, Y. Ye: Linear and Nonlinear Programming, Springer, 2008.
- N. Nocedal, S.J. Wright: Numerical Optimization, Springer, 2006.
- M. Papageorgiou, M. Leibold, M. Buss: Optimierung, Springer, 2012.
- S. Boyd, L. Vandenberghe: Convex Optimization, Cambridge University Press, 2004.
- C.T. Kelley. Iterative Methods for Optimization. SIAM, 1999.

M 4.70 Module: Principles of Medicine for Engineers [M-MACH-102720]

Coordinators: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	2

Mandatory			
T-MACH-105235	Principles of Medicine for Engineers	4 CP	Pylatiuk

Assessment
A performance assessment is held in form of a written examination of 60 minutes.

Prerequisites
none

Competence Goal
Students have a comprehensive understanding of the functioning and anatomical construction of organs, which are assigned to different medical disciplines. Furthermore, they know the physical basics, the technical solutions and the essential aspects of the application of medical technology procedures in diagnostics and therapy. They are familiar with common clinical pictures in the different medical disciplines and their relevance in health care. Through their acquired knowledge, students can communicate with physicians about medical-technical procedures and assess mutual expectations more realistically.

Content
Definition of disease and health and history of medicine, evidence-based medicine" and personalized medicine, nervous system, conduction, musculoskeletal system, cardiovascular system, anesthesia, respiratory system, sensory organs, gynecology, digestive organs, surgery, nephrology, orthopedics, immune system, genetics.

Module Grade Calculation
The module grade is the grade of the written exam.

Workload

1. Attendance time Lecture: 15 * 2h = 30h
2. Pre- and postprocessing time Lecture: 15 * 3h= 45h
3. Exam preparation and attendance exam: 45h

Total: 120h = 4 LP

Recommendations
The content of module MMACH-105228 complements this lecture.

Literature

- Adolf Faller, Michael Schünke: Der Körper des Menschen. Thieme Verlag.
- Renate Huch, Klaus D. Jürgens: Mensch Körper Krankheit. Elsevier Verlag.

M 4.71 Module: Printed and Thin-Film Electronics [M-ETIT-107343]

Coordinators: Prof. Dr. Jasmin Aghassi-Hagmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Specialization: Health Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each winter term	1 term	English	5	1

Mandatory			
T-ETIT-114417	Printed and Thin-Film Electronics	3 CP	Aghassi-Hagmann, Hirtz

Assessment
The assessment takes place in form of an oral examination (approx. 20 minutes).

Prerequisites
none

Competence Goal
The students

- have a general overview over the topic of Printed Electronics and basic knowledge of the materials, manufacturing methods and applications
- can critically analyze the specific advantages and limits of different methods and approaches of manufacturing printed electronics and can thus evaluate the potential for certain applications in relation to classical electronics
- are able to design basic printed electronic devices and know how to characterize their electronic properties
- are enabled to follow current developments in printed electronics and utilize this knowledge in their own research projects
- are enabled to navigate in applications of multidisciplinary nature (physics, material science, medical engineering)
- have gained relevant expertise for responsible R&D positions in industries such as semiconductor, sensors, automation, instrumentation and measurement technology.

Content
This module gives the student an overview over theoretical and practical aspects of printed and thin-film electronics, including applications. It will introduce the basics of manufacturing methods such as 2D / 3D printing, thin-film methods as CVD, PLD, sputtering, nanolithography, e-beam lithography and lift-off processes. Different classes of materials (e.g. inorganic semiconductors, metals, biomaterials, ceramics) and their properties are discussed. Furthermore, the module will introduce the students to applications of printed electronics in a broad range of fields, as IoT, computing, medical wearables, hybrid sensor devices, bioelectronics, and soft robotics.

Module Grade Calculation
The module grade is the grade of the oral examination.

Workload

1. attendance time in lecture: 15*2 h = 30 h
2. preparation/follow-up of the same: 15*2 h = 30 h
3. exam preparation and attendance in the same: 30 h

Total: 90 h = 3 CP

Recommendations
Ideally, this module will be selected by students in combination with “Lab Course Printed and Flexible Electronics”, but this is optional. Basic knowledge in electronic devices, materials of electronics, introductory courses in physics and sensor systems will be beneficial.

M 4.72 Module: Process Analysis: Modeling, Data Mining, Machine Learning [M-ETIT-105594]

Coordinators: Prof. Dr.-Ing. Michael Heizmann
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
3 CP	graded	Each summer term	1 term	German	4	2

Mandatory			
T-ETIT-111214	Process Analysis: Modeling, Data Mining, Machine Learning	3 CP	Borchert, Heizmann

Prerequisites
none

Module Grade Calculation
Die Modulnote ist die Note der mündlichen Prüfung.

M 4.73 Module: Process and Plant Design in Biotechnology [M-CIWVT-107357]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: Core Skills

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-114498	Process and Plant Design in Biotechnology - Seminar	2 CP	Holtmann
T-CIWVT-114499	Process and Plant Design in Biotechnology - Written Exam	4 CP	Holtmann

Assessment
The learning control consists of two partial achievements:

- Examination of another type/ prerequisite for the oral exam: Seminar talk lasting approx. 10 minutes during the course (graded).
- written examination lasting 90 minutes

Prerequisites
The Seminar "Biotechnological Production" is a precondition for admittance to the written exam.

Competence Goal
Students are able to apply the knowledge of unit operations in upstream and downstream processes to plan and evaluate overall processes in biotechnology.They can also use mass and energy balances and graphical representations to implement systems theory considerations for biotechnological processes. Furthermore, they can apply their process engineering knowledge to the planning of biotechnological and biopharmaceutical plants, taking into account hygienic design.

Content
After an introduction to the basic unit operations and their calculation principles, the common basic principles of biotechnological production processes are first discussed. The focus is on the interactions between the biological systems and the process. Flow diagrams and mass and energy balances are discussed using examples. In addition, examples from the areas of hygienic design, sterilization, critical supply media, measurement technology, process analysis technology and formulation are discussed.

Module Grade Calculation
LP-weighted mean of the two partial achievements.

Workload

- Attendance time (Lecture): 60 hrs
- Self-study: 40 hrs
- Preparation presentation at the seminar: 20 hrs
- Attendance time (Lecture): 60 hrs

Literature
Will be announced.

M 4.74 Module: Process and Plant Safety [M-CIWVT-104352]

Coordinators: Hon.-Prof. Dr. Jürgen Schmidt
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-108912	Process and Plant Safety	4 CP	Schmidt

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

The grade of the oral examination is the module grade.

Prerequisites
None

Competence Goal
The students are able to systematically assess the risks of technical systems, assess the effects of possible accidents and define suitable safety measures. The lecture is divided into thematic blocks. Lecture block 01 is an introduction to the topic:

Lecture blocks

1. Introduction
2. risk management
3. hazardous substances
4. Exothermic Chemical Reactions
5. safety devices
6. effluent systems
7. Dispersion of hazardous substances
8. PLT protective devices
9. explosion protection
10. electrostatics

Content
Introduction to safeguarding processes and plants to protect people and the environment from potential hazards of technical plants in the chemical, petrochemical, pharmaceutical and oil and gas sectors. Risk management can be used to prevent incidents and limit the impact of events. This includes topics such as technical safety of plants, risk management, prevention of hazards from substances and dangerous chemical reactions, design of protective devices for emergency relief such as safety valves, bursting discs and downstream containment devices. Modern process control systems, emission and dispersion of hazardous substances in the atmosphere, and explosion and fire protection.

Workload

- Attendance time (Lecture): 30 h
- Homework: 30 h
- Exam Preparation: 60 h

M 4.75 Module: Process Engineering for the Production of Food from Animal Origins [M-CIWVT-106699]

Coordinators: PD Dr. Volker Gaukel
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Food Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-113477	Process Engineering for the Production of Food from Animal Origins	4 CP	Gaukel

Assessment
Learning control is an oral examination with a duration about of 30 minutes.

Prerequisites
None

Competence Goal
Students understand and are able to explain conventional methods for producing foods, even complex ones, from animals. They know unit operations of relevance, both conventional and innovative approaches. They are able to design the processes according to raw material specifics. They identify correlations between process parameters and quality-determining properties of food. They are also able to transfer process knowledge between individual product groups. They know essential aspects required to assess sustainability and energy aspects of the individual process steps and complete process chains.

Students are able to apply principles of product design. This involves identifying the relationships between process parameters and the structure of a food product (process function) as well as between the inner structure of foods and their properties (property function). Based on this, they are able to analyze and solve problems in the field of food process engineering.

Students are able to use their knowledge to evaluate a process unit with regard to food production, involving aspects such as sustainability, energy efficiency, food safety and expected product quality.

Module Grade Calculation
Grade of the module is the grade of oral examination.

Workload
Lectures: 30 h

Homework: 60 h

Exam preparation: 30 h

Literature

- Vorlesungsfolien & Vorlesungsvideos (ILIAS), FAQ zum Vorlesungsstoff und bereit gestellten Materialien (MS Teams)
- H.P. Schuchmann und H. Schuchmann: Lebensmittelverfahrenstechnik: Rohstoffe, Prozesse, Produkte; Wiley VCH, 2005; ISBN: 978-3-527-66054-4 (auch als ebook)
- H.G. Kessler: Lebensmittel- und Bioverfahrenstechnik – Molkereitechnologie, Verlag A. Kessler, 1996, ISBN 3-9802378-4-2
- H.G. Kessler: Food and Bio Process Engineering - Dairy Technology, Publishing House A. Kessler, 2002, ISBN 3-9802378-5-0
- M. Loncin: Die Grundlagen der Verfahrenstechnik in der Lebensmittelindustrie; Aarau Verlag, 1969, ISBN 978-3794107209

M 4.76 Module: Process Engineering for the Production of Food from Plant-Based Raw Materials [M-CIWVT-106698]

Coordinators: Dr.-Ing. Ulrike van der Schaaf
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Food Process Engineering
Specialization: Conversion of Renewable Resources

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-113476	Process Engineering for the Production of Food from Plant-Based Raw Materials	4 CP	van der Schaaf

Assessment
The examination is an oral examination with a duration of about 30 minutes.

The grade of the oral examination is the module grade.

Prerequisites
None

Competence Goal
Students understand and are able to explain conventional methods for producing foods, even complex ones, from plants. They know process chains and unit operations of relevance, both conventional and innovative approaches. They are able to design the processes according to raw material specifics. They identify correlations between process parameters and quality-determining properties of food. They are also able to transfer process knowledge between individual product groups. They know essential aspects required to assess sustainability and energy aspects of the individual process steps and complete process chains.

Students are able to apply principles of product design. This involves identifying the relationships between process parameters and the structure of a food product (process function) as well as between the inner structure of foods and their properties (property function). Based on this, they are able to analyze and solve problems in the field of food process engineering.

Students are able to use their knowledge to evaluate a process unit with regard to food production, involving aspects such as sustainability, energy efficiency, food safety and expected product quality.

Workload

- Attendance time (Lecture): 30 h
- Homework: 60 h
- Exam Preparation: 30 h

Literature

- H.P. Schuchmann und H. Schuchmann: Lebensmittelverfahrenstechnik: Rohstoffe, Prozesse, Produkte; Wiley VCH, 2005; ISBN: 978-3-527-66054-4 (auch als ebook)
- H.G. Kessler: Lebensmittel- und Bioverfahrenstechnik – Molkereitechnologie, Verlag A. Kessler, 1996, ISBN 3-9802378-4-2
- H.G. Kessler: Food and Bio Process Engineering - Dairy Technology, Publishing House A. Kessler, 2002, ISBN 3-9802378-5-0
- M. Loncin: Die Grundlagen der Verfahrenstechnik in der Lebensmittelindustrie; Aarau Verlag, 1969, ISBN 978-3794107209
- Vorlesungsfolien & Vorlesungsvideos (ILIAS), FAQ zum Vorlesungsstoff und bereit gestellten Materialien (MS Teams)

M 4.77 Module: Process Instruments and Machinery and Their Process Integration [M-CIWVT-104351]

Coordinators: Dr.-Ing. Manfred Nagel
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	5	1

Mandatory			
T-CIWVT-108910	Process Instruments and Machinery and Their Process Integration	4 CP	Nagel

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

Competence Goal
Skills to develop holistic processes for product design. Knowledge about task of engineers in process industry.

Content
Teaching of methods and creating awareness about boundary conditions related to scientific and systematic engineering approaches in process development. In Bachelorstudies and during basic studies in process technology focus was laid on the description/analysis of different physical phenomena. Their linkage in the course of selection, dimensioning, interconnection and optimization of apparatuses/ machines and their integration during process development will be outlined and illustrated by a variety of real-life examples.

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 30 h
- Homework: 60 h
- Exam Preparation: 30 h

M 4.78 Module: Process Modeling in Downstream Processing [M-CIWVT-103066]

Coordinators: apl. Prof. Dr. Matthias Franzreb
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Biopharmaceutical Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-106101	Process Modeling in Downstream Processing	4 CP	Franzreb

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

The grade of the oral examination is the module grade.

Prerequisites
None

Competence Goal
Students are able to sum up and explain equilibrium and kinetic equations relevant for chromatography modeling. They are able to explain the methods used for determination of equilibrium and kinetic parameters and can discuss examples. They are familiar with the principle of complex downstream processes, e.g. simulated moving beds, and can explain the differences to conventional chromatography. Using commercial software they are able to simulate chromatography processes and to analyze the results. On this basis they can optimize process parameters and fit them in order to meet given targets such as purity or yield. They can evaluate different processes and choose the variant for a given task.

Content
Fundamentals and practical examples of chromatography modeling,

Design rules for Simulated Moving Beds, Design of Experiments (DOE)

Workload

- Attendance time (Lecture): 30 h
- Homework: 60 h
- Exam Preparation: 30 h

M 4.79 Module: Processes and Process Chains for Renewable Resources [M-CIWVT-104422]

Coordinators: Prof. Dr. Nicolaus Dahmen
Prof. Dr.-Ing. Jörg Sauer
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Conversion of Renewable Resources

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-108997	Processes and Process Chains for Renewable Resources	6 CP	Dahmen, Sauer

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

Competence Goal
The students become able to:

- understand and assess the technical background of the key elements of process chains for the utilization of renewable resources,
- build up the ability for the development of process chains from biomass production via the conversion processes up to product design,
- apply the lessons learned to develop closed process chains for sustainable production of, as example, platform chemicals or material from renewable resources.

Content
The course comprises the following contents:

- Introduction to building a common knowledge base, among others the presentation of today's most important utilization pathway for biomass, biomass potentials, future usage scenarios,
- Essential technical fundamentals for biomass processing. The focus is on the use of lignocellulosic biomass. Procedures for pretreatment, biomass decomposition and separation as well as for conversion of the respective fractions are learned,
- Systematics and analysis of process chains with renewable raw materials based on already established processes such as paper or sugar mills. Extension of the concepts to possible future biorefineries,
- In the exercise, parallel to the lecture, the learned will be applied and implemented by development of an exemplary biorefinery. The results will be presented in a semiar.

Module Grade Calculation
The grade of the oral examination is the module grade.

M 4.80 Module: Processing of Nanostructured Particles [M-CIWVT-103073]

Coordinators: Prof. Dr.-Ing. Hermann Nirschl
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-106107	Processing of Nanostructured Particles	6 CP	Nirschl

Assessment
Learning control is an oranl examination lasting approx. 25 minutes.

Prerequisites
None

Competence Goal
Ability to design a process technology for the manufacturing and production of nanoscale particles

Content
Development of technical process in particle engineering; particle characterisation, interface engineering, particle synthesis;
Typical processes: grinding, mixing, ganulation, selective separation,
classifying; fundamentals of apparatus and devices; simulation techniques, simulation tools

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 60 h
- Homework: 60 h
- Exam Preparation: 60 h

Literature
Skriptum zur Vorlesung

M 4.81 Module: Production and Development of Cancer Therapeutics [M-CIWVT-106563]

Coordinators: PD Dr. Gero Leneweit
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Biopharmaceutical Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-113230	Production and Development of Cancer Therapeutics	4 CP	Leneweit

Assessment
Learning control is an oral examination lasting approx. 30 minutes.

Prerequisites
None

Competence Goal
Students acquire skills to autonomously analyse the product requirements of active substances and drug formulations and to independently plan and realise manufacturing technologies for drug substances and carrier systems.

Content

- Risk factors and stages of carcinogenesis
- therapeutic targets
- mechanisms of chemotherapies, immunotherapies, DNA and RNA therapies
- mechanisms of therapy resistance and overcoming strategies
- drug delivery systems and manufacturing technologies
- scaling; drug loading and coating
- industrial processes
- targeted cancer therapies
- receptors and ligands
- drug accumulation
- (pre-) clinical testing
- regulatory and economic aspects
- innovation potentials and application perspectives

Module Grade Calculation
The module grade ist the grade of the oral exam.

Workload

- Attendance time: 30 hrs
- Self-study: 60 hrs
- Exam preparation: 30 hrs

Literature
Lecture notes with references and topic-specific literature recommendations

M 4.82 Module: Reactor Modeling with CFD [M-CIWVT-106537]

Coordinators: Prof. Dr.-Ing. Gregor Wehinger
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	English	4	1

Mandatory			
T-CIWVT-113224	Reactor Modeling with CFD	4 CP	Wehinger

Assessment
Learning control is an examination of another type: presentation and term paper.

Prerequisites
None

Competence Goal
The students are able to

- describe and apply the mathematical and physical principles of computational fluid dynamics (CFD),
- use the commercial CFD software STAR-CCM+ independently and thoroughly (preprocessing, solving, postprocessing),
- develop a CFD reactor model for an unknown chemical process engineering problem and investigate alternative reactor designs based on this model,
- analyze and evaluate the results obtained, also using virtual reality (VR),
- identify and evaluate errors and uncertainties in CFD models,
- visualize, present, and critically discuss their CFD results in the form of a final report.

Content

1. Conservation laws for momentum, mass and energy
2. The Finite-Volume-Method, solution algorithms, and boundary conditions
3. Computational meshes
4. CFD- Modelling of chemical reactors
5. Use of virtual reality in CFD
6. Basics of writing a scientific paper

Module Grade Calculation
The module grade is the grade of the examination of another type.

Workload

- Attendance time: 45 h
- Self-study: 45 h
- Exam preparation: 30 h

Literature

- Ferziger, Perić: Numerische Strömungsmechanik; 2020 ; Springer
- Versteeg, Malalasekera; An Introduction to Computational Fluid Dynamics: The Finite Volume Method (2nd Edition); 2007; Pearson

M 4.83 Module: Refinery Technology - Liquid Fuels [M-CIWVT-104291]

Coordinators: Prof. Dr. Reinhard Rauch
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-108831	Refinery Technology - Liquid Fuels	6 CP	Rauch

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

The grade of the oral examination is the module grade.

Prerequisites
None

Competence Goal
The students are enabled to balance modern processes for the production of liquid fuels and to put them into context of a modern refinery. This knowledge can be transferred to the evaluation and the development of other processes.

Content
Introduction to liquid chemical fuels: sorces, resources/rerserves, consumption, characteristic properties of raw materials and products, overview of conversion processes.

Petroleum and petroleum refining: characterization of petroleum crude oils and refinery products, physical separation processes, chemical conversion/upgrading processes (chemical equilibrium, rection technology etc.), refinery structures.

Non-conventional liquid fuels e. g. from synthesis processes or biomass feedstocks (vegetable oil and derived fuels, alcohols, synthetic liquid fuels).

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 45 h
- Homework: 75 h
- Exam Preparation: 60 h

Literature

- Elvers, B. (Ed.): Handbook of Fuels, Energy Sources for Transportation, Wiley VCH 2008.
- Lucas, A. G. (Ed.): Modern Petroleum Technology, Vol. 2 Downstream, John Wiley 2000.
- Gary, J.; Handwerk, G., Kaiser, M. J.: Petroleum Refining, Technology and Economics, Fifth Edition, CRC Press 2007

M 4.84 Module: Research Internship [M-CIWVT-107423]

Coordinators: Dr.-Ing. Barbara Freudig
Organisation: KIT Department of Chemical and Process Engineering
Part of: Internship

Credits	Grading	Recurrence	Duration	Language	Level	Version
12 CP	pass/fail	Each term	1 term	German	4	1

Research Internship (Election: at most 12 credits)			
T-CIWVT-114575	Biopharmaceutical Process Engineering	12 CP	Hubbuch
T-CIWVT-114613	Data-Driven Methods in Bioengineering: Modeling and Autonomous Experimentation	12 CP	Franzreb
T-CIWVT-114612	Gas Fermentation	12 CP	Dahmen
T-CIWVT-114574	Intensification of Bio-Processes	12 CP	Holtmann
T-CIWVT-114577	Food Process Engineering	12 CP	van der Schaaf
T-CIWVT-114576	Multiscale Bioengineering	12 CP	Grünberger
T-CIWVT-114614	Water Technology	12 CP	Horn

Workload
360 h.

M 4.85 Module: Rheology of Polymers [M-CIWVT-104329]

Coordinators: Prof. Dr. Norbert Willenbacher
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering
Specialization: Biopharmaceutical Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-CIWVT-108884	Rheology of Polymers	4 CP	Willenbacher

Assessment
The examination is an oral examination with a duration of about 30 minutes.

The duration of the examination differs in the case of a specialized subject comprehensive examination and is approximately 15 minutes.

Prerequisites
None

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 30 h
- Homework: 70 h
- Exam Preparation: 20 h

M 4.86 Module: Seminar of Food Processing in Practice [M-CIWVT-105932]

Coordinators: Dr.-Ing. Nico Leister
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Food Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
2 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-109129	Seminar of Food Processing in Practice with Excursion	2 CP	Leister

Assessment
Learning control is an oral exam with a duration of about 20 minutes.

Competence Goal
Students are able to use their academic knowledge on the processing and characterization of food products to evaluate industrially relevant food processes and techniques. In teams, they can discuss and solve complex tasks that concern the production and evaluation of food products and that stem from industrial applications. Students have the skills to present the results of their work in a scientific manner.

Content
Current challenges in the industrial production of selected food products will be discussed in small groups, and presented to the whole class. The seminar will be accompanied by an excursion to the relevant food processing plants.

Workload

- Attendance time: 30 h
- Self study: 15 h
- Exam preparation: 15 h

M 4.87 Module: Simulation Technologies [M-CIWVT-107038]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: Computer-aided Methods

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	5	1

Mandatory			
T-CIWVT-114104	Simulation Technologies - Exam	3 CP	Meurer
T-CIWVT-114141	Simulation Technologies - Prerequisite	3 CP	Meurer

Assessment
The Learning control consists of two partial achievements:

1. Examination of another type.
2. Oral examination lasting approx. 45 minutes.

Prerequisites
None

Module Grade Calculation
The module grade ist the CP-weighted average of the two partial achievements.

Workload
Attendance time 45 hrs:

- Lectures 30 hrs
- Exercises 15 hrs

Homework 135 hrs:

- Programming task an written elaboration: 30 hrs
- Preparation/ wrap-up of lectures and exercises: 45 hrs
- Exam preparation: 60 hrs

Literature

- Vorlesungsunterlagen
- Schwarz, H.R.; Köckler, N.: Numerische Mathematik, Vieweg+Teubner Verlag Wiesbaden, 2011
- Hoffmann, J.: MATLAB und SIMULINK. Beispielorientierte Einführung in die Simulation dynamischer Systeme. Addison-Wesley 1998

M 4.88 Module: Single-Cell Technologies [M-CIWVT-106564]

Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Micro-Bioprocess Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-CIWVT-113231	Single-Cell Technologies	4 CP	Grünberger

Assessment
The learning control is an oral examination lasting approx. 30 minutes.

Prerequisites
None

Competence Goal
Upon completion of the course, the students are able to:

- Know the fields and interdisciplinary nature of single-cell technologies
- Know basic methods in the field of single-cell technologies
- Are able to evaluate single-cell technologie
- Are able to choose single-cell platforms for specific biological questions
- Are aware of the complexity of the development of single-cell technologies

Content
While cell populations have historically been viewed as homogeneously behaving individuals, new research shows that cell-to-cell heterogeneity exists in all scales of biological systems. While most measurements are based on averages, individual cells can show dramatic differences in their properties such as growth, division and metabolic activity. Single-cell technologies have revolutionized our ability to delve into the intricacies of biological systems. By allowing the analysis of individual cells, these cutting-edge techniques provide insights into cellular heterogeneity, rare cell populations, and dynamic processes. Single-cell technologies range from single-cell microscopy, single-cell omics to single-cell cultivation, which all can be used to uncover hidden layers of complexity of a variety of cell types. These technologies have emerged in the last years and show a transformative, maybe revolutionizing, potential in many fields of basic and applied research of various scientific disciplines. This ranges from microbiology, biomedical research, drug discovery, biotechnology and bioprocess engineering.

The "Single-cell technologies" lecture aims to give an introduction and overview into single-cell technologies and provide students with a comprehensive understanding of the fundamental principles and practical applications of single-cell research. After a short introduction into the field, students will explore various single-cell technologies. Focus will be given on emerging field of microfluidic single-cell cultivation methods and their application. The characteristic features and functionality of selected systems are explained using current examples from science and research. Possibilities for applications in biotechnology and microbiology are discussed. The last part of the lecture provides an insight into single-cell data analysis and future challenges within the field. The course emphasizes the importance of uncovering cellular heterogeneity, and students will discover the role of these technologies in microbiology and biotechnology. They will stay updated on emerging trends and emerging application of this technically complex, but fast developing field. The interdisciplinary nature of single-cell technologies will be emphasized, fostering effective collaboration across fields. State of the art knowledge will be supported by insights into emerging fields and topics within the field. Upon completion, students will be well-prepared to contribute to cutting-edge research and innovations of single-cell technologies. The interdisciplinary and application-oriented lecture is aimed at technically interested students of molecular biotechnology, microbiology, biochemistry, bioprocess engineering, chemical engineering as well as all interested students of life sciences, chemistry, and physics.

Module Grade Calculation
The module grade is the grade of the oral exam.

Workload

- Attendance time: 30 hrs
- Self-study: 50 hrs
- Exam preparation: 40 hrs

Literature
No specific textbook is recommended.

M 4.89 Module: Solid Liquid Separation [M-CIWVT-104342]

Coordinators: Dr.-Ing. Marco Gleiß
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
8 CP	graded	Each winter term	1 term	German	5	1

Mandatory			
T-CIWVT-108897	Solid Liquid Separation	8 CP	Gleiß

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

Competence Goal
The students are able to apply the fundamental laws and the derived physical principles of the particle separation from liquids and not only to relate them to the principally suited separation apparatuses but also special variants. They have the ability to apply the relationship betwen product operation and design parameters to different separation techniques. They can analyse separation problems with scientific methods and give alternative problem solution proposals.

Content
physical fundamentals, apparatuses, applications,strategies; characterisation of particle systems and slurries; pretreatment methods to enhance the separability of slurries; fundamentals, apparatuses and process technology of static and centrifugal sedimentation, flotation, depth filtration, crossflow filtration, cake forming vacuum and gas overpressure filtration, filter centrifuges and press filters; filter media; selection criteria and scale-up methods for separation apppartuses and machines; apparatus combinations; case studies to solve sparation problems

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload

- Attendance time (Lecture): 60 h
- Homework: 80 h
- Exam Preparation: 100 h

Literature
Anlauf: Skriptum "Mechanische Separationstechnik - Fest/Flüssig-Trennung"

M 4.90 Module: Stability of Disperse Systems [M-CIWVT-104330]

Coordinators: Prof. Dr. Norbert Willenbacher
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering
Specialization: Food Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
4 CP	graded	Each winter term	1 term	German	4	1

Mandatory			
T-CIWVT-108885	Stability of Disperse Systems	4 CP	Willenbacher

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

The duration of the examination differs in the case of a specialized subject comprehensive examination and is approximately 15 minutes.

Prerequisites
None

Module Grade Calculation
The grade of the oral examination is the module grade.

Workload
• Attendance time (Lecture): 30 h
• Homework: 70 h
• Exam Preparation: 20 h

M 4.91 Module: Supplementary Studies on Science, Technology and Society [M-FORUM-106753]

Coordinators: Dr. Christine Mielke
Christine Myglas
Organisation: General Studies. Forum Science and Society (FORUM)
Part of: Additional Achievements

Credits	Grading	Recurrence	Duration	Language	Level	Version
16 CP	graded	Each term	3 terms	German	4	1

Election Notes
Students have to self-record the achievements obtained in the Supplementary Studies on Science, Technology and Society in their study plan. FORUM (formerly ZAK) records the achievements as "non-assigned" under "ÜQ/SQ-Leistungen". Further instructions on self-recording of achievements can be found in the FAQ at https://campus.studium.kit.edu/ and on the FORUM homepage at https://www.forum.kit.edu/english/. The title of the examination and the amount of credits override the modules placeholders.

If you want to use FORUM achievements for both your Interdisciplinary Qualifications and for the Supplementary Studies, please record them in the Interdisciplinary Qualifications first. You can then get in contact with the FORUM study services (stg@forum.kit.edu) to also record them in your Supplementary Studies.

In the Advanced Unit you can choose examinations from three subject areas: "About Knowledge and Science", "Science in Society" and "Science in Social Debates". It is advised to complete courses from each of the three subject areas in the Advanced Unit.

To self-record achievements in the Advanced Unit, you have to select a free placeholder partial examination first. The placeholders' title do *not* affect which achievements the placeholder can be used for!

Mandatory			
T-FORUM-113578	Lecture Series Supplementary Studies on Science, Technology and Society - Self Registration	2 CP	Mielke, Myglas
T-FORUM-113579	Basic Seminar Supplementary Studies on Science, Technology and Society - Self Registration	2 CP	Mielke, Myglas
Advanced Unit Supplementary Studies on Science, Technology and Society (Election: at least 12 credits)			
T-FORUM-113580	Elective Specialization Supplementary Studies on Science, Technology and Society / About Knowledge and Science - Self-Registration	3 CP	Mielke, Myglas
T-FORUM-113581	Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Society - Self-Registration	3 CP	Mielke, Myglas
T-FORUM-113582	Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Public Debates - Self Registration	3 CP	Mielke, Myglas
Mandatory			
T-FORUM-113587	Registration for Certificate Issuance - Supplementary Studies on Science, Technology and Society	0 CP	Mielke, Myglas

Assessment
The monitoring is explained in the respective partial achievement.

They are composed of:
- Protocols
- Reflection reports
- Presentations
- Preparation of a project work
- An individual term paper
- An oral examination
- A written exam

Upon successful completion of the supplementary studies, graduates receive a graded report and a certificate issued by the FORUM.

Prerequisites
The course is offered during the course of study and does not have to be completed within a defined period. Enrollment is required for all assessments of the modules in the supplementary studies.
Participation in the supplementary studies is regulated by § 3 of the statutes. KIT students register for the supplementary studies by selecting this module in the student portal and booking a performance themselves. Registration for courses, assessments, and exams is regulated by § 8 of the statutes and is usually possible shortly before the start of the semester.
The course catalog, module description (module manual), statutes (study regulations), and guidelines for creating the various written performance requirements can be downloaded from the FORUM homepage at https://www.forum.kit.edu/begleitstudium-wtg.php.

Registration and exam modalities
PLEASE NOTE:
Registration on the FORUM, i.e. additionally via the module selection in the student portal, enables students to receive up-to-date information about courses or study modalities. In addition, registering on the FORUM ensures that you have proof of the credits you have earned. As it is currently (as of winter semester 24-25) not yet possible to continue additional credits acquired in the Bachelor's programme electronically in the Master's programme, we strongly advise you to digitally secure the credits you have earned by archiving the Bachelor's transcript of records yourself and by registering on FORUM.
In the event that a transcript of records of the Bachelor's certificate is no longer available - we can only assign the achievements of registered students and thus take them into account when issuing the certificate.

Competence Goal
Graduates of the Supplementary Studies on Science, Technology, and Society gain a solid foundation in understanding the interplay between science, the public, business, and politics. They develop practical skills essential for careers in media, political consulting, or research management. The program prepares them to foster innovation, influence social processes, and engage in dialogue with political and societal entities. Participants are introduced to interdisciplinary perspectives, encompassing social sciences and humanities, to enhance their understanding of science, technology, and society. The teaching objectives of this supplementary degree program include equipping participants with both subject-specific knowledge and insights from epistemological, economic, social, cultural, and psychological perspectives on scientific knowledge and its application in various sectors. Students are trained to critically assess and balance the implications of their actions at the intersection of science and society. This training prepares them for roles as students, researchers, future decision-makers, and active members of society.

Through the program, participants learn to contextualize in-depth content within broader frameworks, independently analyze and evaluate selected course materials, and communicate their findings effectively in both written and oral formats. Graduates are adept at analyzing social issues and problem areas, reflecting on them critically from a socially responsible and sustainable standpoint.

Content
The Supplementary Studies on Science, Technology and Society can be started in the 1st semester of the enrolled degree programme and is not limited in time. The wide range of courses offered by FORUM makes it possible to complete the program usually within three semesters. The supplementary studies comprises 16 or more credit points (LP). It consists of **two modules: the Basic Module (4 LP) and the Advanced Module (12 LP).**

The **basic Module** comprises the compulsory courses 'Lecture Series Supplementary Studies on Science, Technology and Society' and a basic seminar with a total of 4 LP.

The **Advanced Module** comprises courses totalling 12 LP in the humanities and social sciences subject areas 'On Knowledge and Science', 'Science in Society' and 'Science in Public Debates'. The allocation of courses to the accompanying study programme can be found on the homepage https://www.forum.kit.edu/wtg-aktuelland in the printed FORUM course catalogue.

The 3 thematic subject areas:

Subject area 1: About Knowledge and Science

This is about the internal perspective of science: students explore the creation of knowledge, distinguishing between scientific and non-scientific statements (e.g., beliefs, pseudo-scientific claims, ideological statements), and examining the prerequisites, goals, and methods of knowledge generation. They investigate how researchers address their own biases, analyze the structure of scientific explanatory and forecasting models in various disciplines, and learn about the mechanisms of scientific quality assurance.

After completing courses in the "Knowledge and Science" area, students can critically reflect on the ideals and realities of contemporary science. They will be able to address questions such as: How robust is scientific knowledge? What are the capabilities and limitations of predictive models? How effective is quality assurance in science, and how can it be improved? What types of questions can science answer, and what questions remain beyond its scope?

Subject area 2: Science in Society

This focuses on the interactions between science and different areas of society, such as how scientific knowledge influences social decision-making and how social demands impact scientific research. Students learn about the specific functional logics of various societal sectors and, based on this understanding, estimate where conflicts of goals and actions might arise in transfer processes—for example, between science and business, science and politics, or science and journalism. Typical questions in this subject area include: How and under what conditions does an innovation emerge from a scientific discovery? How does scientific policy advice work? How do business and politics influence science, and when is this problematic? According to which criteria do journalists incorporate scientific findings into media reporting? Where does hostility towards science originate, and how can social trust in science be strengthened?

After completing courses in the "Sciene in Society" area, students can understand and assess the goals and constraints of actors in different societal sectors. This equips them to adopt various perspectives of communication and action partners in transfer processes and to act competently at various social interfaces with research in their professional lives.

Subject area 3: Science in Public Debates

The courses in this subject area provide insights into current debates on major social issues such as sustainability, digitalization, artificial intelligence, gender equality, social justice, and educational opportunities. Public debates on complex challenges are often polarized, leading to oversimplifications, defamation, or ideological thinking. This can hinder effective social solution-finding processes and alienate people from the political process and from science. Debates about sustainable development are particularly affected, as they involve a wide range of scientific and technological knowledge in both problem diagnosis (e.g., loss of biodiversity, climate change, resource consumption) and solution development (e.g., nature conservation, CCS, circular economy).

By attending courses in "Science in Public Debates," students are trained in an application-oriented way to engage in factual debates—exchanging arguments, addressing their own prejudices, and handling contradictory information. They learn that factual debates can often be conducted more deeply and with more nuance than is often seen in public discourse. This training enables them to handle specific factual issues in their professional lives independently of their own biases and to be open to differentiated, fact-rich arguments.

Supplementary credits:
Additional LP (supplementary work) totalling a maximum of 12 LP can also be acquired from the complementary study programme (see statutes for the WTG complementary study programme § 7). § 4 and § 5 of the statutes remain unaffected by this. These supplementary credits are not included in the overall grade of the accompanying study programme. At the request of the participant, the supplementary work will be included in the certificate of the accompanying study programme and marked as such. Supplementary coursework is listed with the grades provided for in § 9.

Module Grade Calculation
The overall grade of the supplementary course is calculated as a credit-weighted average of the grades that were achieved in the advanced module.

Additional Information
Climate change, biodiversity crisis, antibiotic resistance, artificial intelligence, carbon capture and storage, and gene editing are just a few areas where science and technology can diagnose and address numerous social and global challenges. The extent to which scientific findings are considered in politics and society depends on various factors, such as public understanding and trust, perceived opportunities and risks, and ethical, social, or legal considerations.
To enable students to use their expertise as future decision-makers in solving social and global challenges, we aim to equip them with the skills to navigate the interfaces between science, business, and politics competently and reflectively. In the Supplementary Studies, they acquire foundational knowledge about the interactions between science, technology, and society.

They learn:
- How reliable scientific knowledge is produced,
- how social expectations and demands influence scientific research, and
- how scientific knowledge is adopted, discussed, and utilized by society.

The program integrates essential insights from psychology, philosophy, economics, social sciences, and cultural studies into these topics. After completing the supplementary studies programme, students can place the content of their specialized studies within a broader social context. This prepares them, as future decision-makers, to navigate competently and reflectively at the intersections between science and various sectors of society, such as politics, business, or journalism, and to contribute effectively to innovation processes, public debates, or political decision-making.

Workload
The workload is made up of the number of hours of the individual modules:

- Basic Module approx. 120 hours
- Advanced Module approx. 360 hours
> Total: approx. 480 hours

In the form of supplementary services, up to approximately 360 hours of work can be added.

Recommendations
It is recommended to complete the supplementary study program in three or more semesters, beginning with the lecture series on science, technology, and society in the summer semester. Alternatively, you can start with the basic seminar in the winter semester and then attend the lecture series in the summer semester.

Courses in the Advanced Module can be taken simultaneously. It is also advised to complete courses from each of the three subject areas in the advanced unit.

Teaching and Learning Methods
- Lectures
- Seminars/Project Seminars
- Workshops

M 4.92 Module: Thermal Process Engineering II [M-CIWVT-107039]

Coordinators: Prof. Dr.-Ing. Tim Zeiner
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-114107	Thermal Process Engineering II	6 CP	Zeiner

Assessment
Leaning control is a written examination lasting 180 minutes.

Prerequisites
None

Competence Goal
Students are able to independently evaluate and model processes for separating mixtures of substances. They can also optimize these unit operations for specific separations.

Content
The lecture covers the extension of basic thermal operations. Drying, membrane processes, and chromatography as separation methods are introduced. In addition, the rectification of real systems and multi-component rectification are considered. Furthermore, crystallization is explored in greater depth. Another focus is on process intensification and synthesis in order to make processes more efficient and resource-friendly. Finally, possibilities for process simulation are presented.

Module Grade Calculation
The module grade ist the grade of the written exam.

Workload

- Lectures and exercises: 45 hrs
- Homework: 90 hrs
- Exam preparation: 45 hrs

M 4.93 Module: Thermal Process Engineering III [M-CIWVT-107040]

Coordinators: Prof. Dr.-Ing. Tim Zeiner
Organisation: KIT Department of Chemical and Process Engineering
Part of: Process Engineering

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	German	5	1

Mandatory			
T-CIWVT-114108	Thermal Process Engineering III	6 CP	Zeiner

M 4.94 Module: Thermodynamics for Bioengineering [M-CIWVT-107386]

Coordinators: Prof. Dr. Sabine Enders
Prof. Dr.-Ing. Tim Zeiner
Organisation: KIT Department of Chemical and Process Engineering
Part of: Core Skills

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each summer term	1 term	German	4	1

Mandatory			
T-CIWVT-114497	Thermodynamics for Bioengineering	6 CP	Enders, Zeiner

Assessment
Learning control ist an oral exam lasting approx. 30 minutes.

Prerequisites
None.

Competence Goal
The participants know the possibilities and the limits for the application of thermodynamics in bioengineering.

Content
Principle of partial molar quantities, thermodynamic models, electrolyte solutions, polymer solutions, application of thermodynamics for processes in bioengineering (e.g. aqueous two-phase extraction, fermentation, separation of isomers).

Module Grade Calculation
The grade of the module ist the grade of the oral exam.

Workload

- Lectures and Exercises: 60 h
- Homework: 60 h
- Exam preparation: 60 h

Recommendations
Thermodynamics II.

M 4.95 Module: Water Technology [M-CIWVT-103407]

Coordinators: Prof. Dr. Harald Horn
Organisation: KIT Department of Chemical and Process Engineering
Part of: Specialization: Water Technology

Credits	Grading	Recurrence	Duration	Language	Level	Version
6 CP	graded	Each winter term	1 term	English	4	1

Mandatory			
T-CIWVT-106802	Water Technology	6 CP	Horn

Assessment
Oral exam, 30 min

Prerequisites
None

Competence Goal
Students learn fundamental knowledge in water chemistry and how to apply it to processes in aquatic systems in general and in reactors for water treatment. Water treatment will be taught for drinking water and partly waste water. The students are able to apply physical, chemical and biochemical treatment for the respective removal of particulate and dissolved components in water. They are able to use the fundamental design parameters for the different types of unit operations.

Content
Water cycle, different types of raw water (ground and surface water). Water as solvent, carbonate balance, differentiation between microbiological and chemical population. Unit operations: sieving, sedimentation, filtration, flocculation, flotation, ion exchange, aeration, oxidation, disinfection, adsorption). For all unit operations design parameters will be provided. Simple 1D models will be discussed for description of kinetics and retention time in reactors for water treatment.

Workload
Attendance time: 45 h
Preparation/follow-up: 60 h
Examination + exam preparation: 75 h

Literature
Crittenden, J. C. et al. (2012): Water treatment – Principles and design. 3. edition, Wiley & Sons, Hoboken.

Jekel, M., Czekalla, C. (Hrsg.) (2016). DVGW Lehr- und Handbuch der Wasserversorgung. Deutscher Industrieverlag.

Lecture notes will be provided in ILIAS

5 Module components

T 5.1 Module component: Additive Manufacturing for Process Engineering - Examination [T-CIWVT-110902]

Coordinators: TT-Prof. Dr. Christoph Klahn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105407 - Additive Manufacturing for Process Engineering

Type	Credits	Grading	Term offered	Version
Oral examination	5 CP	graded	Each summer term	1

Courses					
ST 2025	2241020	Additive Manufacturing for Process Engineering	2 SWS	Lecture / 🗣	Klahn

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral examination with a duration of about 30 minutes.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-110903 - Practical in Additive Manufacturing for Process Engineering must have been passed.

T 5.2 Module component: Advanced Artificial Intelligence [T-INFO-114220]

Coordinators: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107198 - Advanced Artificial Intelligence

Type	Credits	Grading	Term offered	Version
Written examination	6 CP	graded	Each summer term	1

Courses					
ST 2025	2400141	Advanced Artificial Intelligence	4 SWS	Lecture / 🗣	Niehues, Lioutikov

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
None.

T 5.3 Module component: Alternative Protein Technologies [T-CIWVT-113429]

Coordinators: PD Dr.-Ing. Azad Emin
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106661 - Alternative Protein Technologies

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2211330	Alternative Protein Technologies	2 SWS	Block / 🗣	Emin

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control is an oral examination lasting approx. 20 minutes.

Prerequisites
None

T 5.4 Module component: Basic Seminar Supplementary Studies on Science, Technology and Society - Self Registration [T-FORUM-113579]

Coordinators: Dr. Christine Mielke
Christine Myglas
Organisation: General Studies. Forum Science and Society (FORUM)
Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Term offered	Expansion	Version
Coursework	2 CP	pass/fail	Each summer term	1 semesters	1

Assessment
Study achievement in the form of a presentation or a term paper or project work in the selected course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This module component can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
It is recommended that the basic seminar be completed during the same semester as the lecture series "Science in Society". If it is not possible to attend the lecture series and the basic seminar in the same semester, the basic seminar can also be attended in the semesters before the lecture series.
However, attending courses in the advanced unit before attending the basic seminar should be avoided.

T 5.5 Module component: Batteries, Fuel Cells, and Electrolysis [T-ETIT-113986]

Coordinators: Prof. Dr.-Ing. Ulrike Krewer
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-107005 - Batteries, Fuel Cells, and Electrolysis

Type	Credits	Grading	Term offered	Version
Written examination	6 CP	graded	Each winter term	2

Courses					
WT 25/26	2304240	Batteries, Fuel Cells and Electrolysis	2 SWS	Lecture /	Krewer
WT 25/26	2304241	Practical Exercise to 2304240 Batteries, Fuel Cells and Electrolysis	2 SWS	Practice /	Krewer, Sonder

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
Success control takes place in the form of a written examination lasting 120 minutes.

Prerequisites
The following module components must not have started:

- T-ETIT-100983 - Batterien und Brennstoffzellen
- T-ETIT-114097 - Batterien, Brennstoffzellen und ihre Systeme

T 5.6 Module component: Biobased Plastics [T-CIWVT-109369]

Coordinators: Prof. Dr. Ralf Kindervater
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104570 - Biobased Plastics

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2212820	Biobased Plastics	2 SWS	Lecture / 🗣	Kindervater, Syldatk, Schmiedl

Legend: 💻 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Verteifungsfach:

The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Technisches Ergänzungsfach or a large number of aatudents:

The examination is a written examination with a duration of 90 minutes (section 4 subsection 2 number 1 SPO).

Prerequisites
None

T 5.7 Module component: Biofilm Systems [T-CIWVT-106841]

Coordinators: Dr. Andrea Hille-Reichel
Dr. Michael Wagner
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103441 - Biofilm Systems

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2233820	Biofilm Systems	2 SWS	Lecture /	Hille-Reichel, Wagner

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
Oral exam, about 20 min.

T 5.8 Module component: BioMEMS - Microfludic Chipsystems V [T-MACH-111069]

Coordinators: Prof. Dr. Andreas Guber
Dr. Taleieh Rajabi

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105484 - BioMEMS - Microfludic Chipsystems V

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	4 CP	graded	Each winter term	1 semesters	2

Assessment
oral exam (appr. 20 Min.)

Prerequisites
none

Additional Information
The course is offered in German

Workload
120 hours

T 5.9 Module component: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I [T-MACH-100966]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100489 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine I

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each winter term	3

Courses					
WT 25/26	2141864	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I	2 SWS	Lecture / 🗣	Guber, Ahrens

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam (75 Min.)

Prerequisites
none

Additional Information
The course is offered in German

Workload
120 hours

T 5.10 Module component: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II [T-MACH-100967]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100490 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine II

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each summer term	3

Courses					
ST 2025	2142883	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II	2 SWS	Lecture / 🗣	Guber, Ahrens

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written exam (75 Min.)

Prerequisites
none

Additional Information
The course is offered in German

Workload
120 hours

T 5.11 Module component: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III [T-MACH-100968]

Coordinators: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-100491 - BioMEMS - Microsystems Technologies for Life Sciences and Medicine III

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each summer term	3

Courses					
ST 2025	2142879	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III	2 SWS	Lecture / 🗣	Guber, Ahrens

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written exam (75 Min.)

Prerequisites
none

Additional Information
The course is offered in German

Workload
120 hours

T 5.12 Module component: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV [T-MACH-106877]

Coordinators: Dr. Ralf Ahrens
Prof. Dr. Andreas Guber

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-105483 - BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
ST 2025	2142893	BioMEMS IV - Microsystems technology for Life Sciences and Medicine	2 SWS	/ ✕	Ahrens, Länge, Doll
WT 25/26	2141102	BioMEMS IV - Microsystems technology for Life Sciences and Medicine	2 SWS	Lecture / 🗣	Guber, Ahrens, Länge

Legend: 🖳 Online, 🖳🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Oral examination (45 Min.)

Prerequisites
none

Additional Information
The course is offered in German

Workload
120 hours

T 5.13 Module component: Biopharmaceutical Process Engineering [T-CIWVT-114575]

Coordinators: Prof. Dr. Jürgen Hubbuch
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107423 - Research Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

T 5.14 Module component: Biopharmaceutical Purification Processes [T-CIWVT-106029]

Coordinators: Prof. Dr. Jürgen Hubbuch
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103065 - Biopharmaceutical Purification Processes

Type	Credits	Grading	Version
Written examination	6 CP	graded	1

Courses					
WT 25/26	2214010	Biopharmaceutical Purification Processes	3 SWS	Lecture / 🗣	Hubbuch, Franzreb
WT 25/26	2214011	Exercises on 2214010 Biopharmaceutical Purification Processes	1 SWS	Practice / 🗣	Hubbuch, Franzreb

Legend: 💻 Online, 💐 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is a written examination with a duration of 120 minutes (section 4 subsection 2 number 1 SPO).

T 5.15 Module component: Bioprocess Scale-up [T-CIWVT-113712]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106837 - Bioprocess Scale-up

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each winter term	2

Courses					
WT 25/26	2213040	Bioprocess Scale-Up	2 SWS	Lecture /	Grünberger
WT 25/26	2213041	Exercises to 2213040 Bioprocess Scale-Up	1 SWS	Practice /	Grünberger

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

T 5.16 Module component: Bioreactor Development [T-CIWVT-113315]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106595 - Bioreactor Development

Type	Credits	Grading	Version
Examination of another type	4 CP	graded	2

Courses					
ST 2025	2210020	Team Project "99€ Bioreactor": Development of an Innovative Bioreactor Concept	2 SWS	Project (P / 🗣	Grünberger, Holtmann

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None

T 5.17 Module component: Biosensors [T-CIWVT-113714]

Coordinators: Dr. Gözde Kabay
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106838 - Biosensors

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each term	1

Courses					
ST 2025	2214810	Biosensors	2 SWS	Lecture /	Kabay
WT 25/26	2214810	Biosensors	2 SWS	Lecture /	Kabay

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Prerequisites
None

T 5.18 Module component: Biotechnological Use of Renewable Resources [T-CIWVT-113237]

Coordinators: Prof. Dr. Christoph Syldatk
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105295 - Biotechnological Use of Renewable Resources

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2212210	Biotechnological Use of Renewable Resources	2 SWS	Lecture / 🗣	Syldatk

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The learning control is an oral examination lasting about 20 minutes.

Prerequisites
None

T 5.19 Module component: C1-Biotechnology Exam [T-CIWVT-113677]

Coordinators: Dr. Anke Neumann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106816 - C1-Biotechnology

Type	Credits	Grading	Version
Oral examination	4 CP	graded	1

Courses					
WT 25/26	2212130	C1-Biotechnology	2 SWS	Lecture /	Neumann
WT 25/26	2212131	Exercises on 2212130 C1-Biotechnology	1 SWS	Practice /	Neumann

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-113678 - C1-Biotechnology Presentation must have been passed.

T 5.20 Module component: C1-Biotechnology Presentation [T-CIWVT-113678]

Coordinators: Dr. Anke Neumann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106816 - C1-Biotechnology

Type	Credits	Grading	Version
Coursework	2 CP	pass/fail	2

Courses					
WT 25/26	2212130	C1-Biotechnology	2 SWS	Lecture /	Neumann
WT 25/26	2212131	Exercises on 2212130 C1-Biotechnology	1 SWS	Practice /	Neumann

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

T 5.21 Module component: Commercial Biotechnology [T-CIWVT-108811]

Coordinators: Prof. Dr. Ralf Kindervater
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104273 - Commercial Biotechnology

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2212810	Commercial Biotechnology	2 SWS	Lecture / 🗣	Kindervater, und Mitarbeitende

Legend: 📱 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

In case of large number of participants the examination is a written examination with a duration of 60 minutes (section 4 subsection 2 number 1 SPO).

Prerequisites
None

T 5.22 Module component: Computational Fluid Dynamics [T-CIWVT-106035]

Coordinators: Prof. Dr.-Ing. Hermann Nirschl
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103072 - Computational Fluid Dynamics

Type	Credits	Grading	Term offered	Version
Written examination	6 CP	graded	Each term	1

Courses					
WT 25/26	2245020	Computational Fluid Dynamics	2 SWS	Lecture / 🗣	Nirschl, und Mitarbeitende
WT 25/26	2245021	Exercises for 2245020 Computational Fluid Dynamics	1 SWS	Practice / 🗣	Nirschl, und Mitarbeitende

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is a written examination lasting 90 minutes.

Prerequisites
None

T 5.23 Module component: Computational Fluid Dynamics and Simulation Lab [T-MATH-113373]

Coordinators: Prof. Dr. Martin Frank
PD Dr. Mathias Krause
Dr. Stephan Simonis
PD Dr. Gudrun Thäter

Organisation: KIT Department of Mathematics

Part of: M-MATH-106634 - Computational Fluid Dynamics and Simulation Lab

Type	Credits	Grading	Version
Examination of another type	4 CP	graded	1

Courses					
ST 2025	0161700	Computational Fluid Dynamics and Simulation Lab	4 SWS	Practical course	Thäter, Krause, Simonis

Prerequisites
none

Workload
120 hours

T 5.24 Module component: Data-Based Modeling and Control [T-CIWVT-112827]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106319 - Data-Based Modeling and Control

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Courses					
WT 25/26	2243070	Data-Based Modeling and Control	3 SWS	Lecture / Practice (/	Meurer

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

T 5.25 Module component: Data-Driven Methods in Bioengineering: Modeling and Autonomous Experimentation [T-CIWVT-114613]

Coordinators: apl. Prof. Dr. Matthias Franzreb
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107423 - Research Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

T 5.26 Module component: Data-Driven Models in Python - Process Engineering Project [T-CIWVT-113708]

Coordinators: Dr.-Ing. Frank Rhein
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106835 - Data-Driven Process Engineering Models in Python

Type	Credits	Grading	Version
Coursework	3 CP	pass/fail	1

Courses					
WT 25/26	2245320	Data-Driven Modeling with Python	2 SWS	Lecture / 🗣	Rhein
WT 25/26	2245321	Project Work on 2245320 Data-Driven Modeling with Python	1 SWS	Practice / 🗣	Rhein

Legend: 🖳 Online, 🖳🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 5.27 Module component: Data-Driven Process Engineering Models in Python - Exam [T-CIWVT-113709]

Coordinators: Dr.-Ing. Frank Rhein
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106835 - Data-Driven Process Engineering Models in Python

Type	Credits	Grading	Version
Oral examination	1 CP	graded	1

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-113708 - Data-Driven Models in Python - Process Engineering Project must have been passed.

T 5.28 Module component: Deep Learning and Neural Networks [T-INFO-114219]

Coordinators: Prof. Dr. Jan Niehues
Organisation: KIT Department of Informatics
Part of: M-INFO-107197 - Deep Learning and Neural Networks

Type	Credits	Grading	Term offered	Version
Written examination	6 CP	graded	Each summer term	1

Courses					
ST 2025	2400024	Deep Learning and Neural Networks	4 SWS	Lecture / 🗣	Niehues

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The assessment is carried out as a written examination (§ 4 Abs. 2 No. 1 SPO) lasting 60 minutes.

Prerequisites
T-INFO-101383 - Neural networks must not be started.

Recommendations
Prior successful completion of the core module "Cognitive Systems" is recommended.

T 5.29 Module component: Development of an Innovative Food Product [T-CIWVT-108960]

Coordinators: Dr.-Ing. Ulrike van der Schaaf
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104388 - Development of an Innovative Food Product

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	2

Courses					
ST 2025	2211220	Team Project "Eco TROPHELIA": Development of an Innovative Food Product	3 SWS	Project (P / 🗣)	van der Schaaf, und Mitarbeitende
WT 25/26	2211220	Team Project "Eco TROPHELIA": Development of an Innovative Food Product	3 SWS	Project (P / 🗣)	van der Schaaf, Ellwanger

Legend: 🖥 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control is an examination of another kind: a written elaboration

Prerequisites
None

T 5.30 Module component: Development of an Innovative Food Product - Presentation [T-CIWVT-111010]

Coordinators: Dr.-Ing. Ulrike van der Schaaf
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104388 - Development of an Innovative Food Product

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Courses					
ST 2025	2211220	Team Project "Eco TROPHELIA": Development of an Innovative Food Product	3 SWS	Project (P / 🗣)	van der Schaaf, und Mitarbeitende
WT 25/26	2211220	Team Project "Eco TROPHELIA": Development of an Innovative Food Product	3 SWS	Project (P / 🗣)	van der Schaaf, Ellwanger

Legend: 🖥 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Success control is an examination of another kind: Seminar/ Presentation.

Prerequisites
None

T 5.31 Module component: Digital Design in Process Engineering - Laboratory [T-CIWVT-111582]

Coordinators: TT-Prof. Dr. Christoph Klahn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105782 - Digital Design in Process Engineering

Type	Credits	Grading	Version
Coursework (practical)	3 CP	pass/fail	1

Courses					
WT 25/26	2241031	Practical Course Digital Design in Process Engineering	2 SWS	Practical course / 🗣	Klahn, Jayavelu

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Laboratory, ungraded.

Prerequisites
None.

T 5.32 Module component: Digital Design in Process Engineering - Oral Examination [T-CIWVT-111583]

Coordinators: TT-Prof. Dr. Christoph Klahn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105782 - Digital Design in Process Engineering

Type	Credits	Grading	Version
Oral examination	3 CP	graded	1

Courses					
WT 25/26	2241030	Digital Design in Process Engineering	2 SWS	Lecture / 🗣	Klahn

Legend: Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
Learning control is an oral examination with a duration of about 30 minutes according to SPO section 4, subsection 2 No. 2.

Prerequisites
Participation in the laboratory.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-111582 - Digital Design in Process Engineering - Laboratory must have been passed.

T 5.33 Module component: Digitization in Particle Technology [T-CIWVT-110111]

Coordinators: Dr.-Ing. Marco Gleiß
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104973 - Digitization in Particle Technology

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2245220	Digitization in Particle Technology	2 SWS	Lecture / 🗣	Gleiß, und Mitarbeitende

Legend: 💻 Online, 🎭 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral examination lasting approx. 30 minutes.

Prerequisites
None

T 5.34 Module component: Digitization in Particle Technology - Project Work [T-CIWVT-114694]

Coordinators: Dr.-Ing. Marco Gleiß
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104973 - Digitization in Particle Technology

Type	Credits	Grading	Version
Coursework (practical)	2 CP	pass/fail	1

Courses					
WT 25/26	2245221	Project Work on 2245220 Digitization in Particle Technology	1 SWS	Project (P / 🗣	Gleiß, und Mitarbeitende

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

T 5.35 Module component: Dynamics of Process Engineering Systems - Exam [T-CIWVT-114106]

Coordinators: Dr.-Ing. Pascal Jerono
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107037 - Dynamics of Process Engineering Systems

Type	Credits	Grading	Term offered	Version
Oral examination	3 CP	graded	Each summer term	1

Courses					
ST 2025	2243120	Dynamics of Process Engineering Systems	2 SWS	Lecture / 🗣	Jerono
ST 2025	2243121	Dynamics of Process Engineering Systems - Exercises	1 SWS	Practice / 🗣	Jerono

Legend: 💻 Online, 🌼 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral exam lasting approx. 45 minutes.

Prerequisites
The written elaboration is a prerequisite for the oral exam
T-CIWVT-114105 - Dynamics Process Engineering Systems - Prerequisite

T 5.36 Module component: Dynamics Process Engineering Systems - Prerequisite [T-CIWVT-114105]

Coordinators: Dr.-Ing. Pascal Jerono
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107037 - Dynamics of Process Engineering Systems

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each summer term	1

Courses					
ST 2025	2243120	Dynamics of Process Engineering Systems	2 SWS	Lecture / 🗣	Jerono
ST 2025	2243121	Dynamics of Process Engineering Systems - Exercises	1 SWS	Practice / 🗣	Jerono

Legend: 💻 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an examination of another type:
Written elaboration on a task that is handed out in the lecture.

Prerequisites
None

T 5.37 Module component: Elective Specialization Supplementary Studies on Science, Technology and Society / About Knowledge and Science - Self-Registration [T-FORUM-113580]

Coordinators: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Assessment
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This module component can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Additional Information
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

In the Advanced Module, students can choose their own individual focus, e.g. sustainable development, data literacy, etc. The focus should be discussed with the module coordinator at the FORUM.

T 5.38 Module component: Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Public Debates - Self Registration [T-FORUM-113582]

Coordinators: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Assessment
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This module component can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Additional Information
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

T 5.39 Module component: Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Society - Self-Registration [T-FORUM-113581]

Coordinators: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each term	1

Assessment
Another type of examination assessment under § 5, section 3 involves a presentation, term paper, or project work within the chosen course.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This module component can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
The contents of the basic module are helpful. The basic module should be completed or attended in parallel, but not after the advanced module.
The reading recommendations for primary and specialist literature are determined individually by the respective lecturers according to the subject area and course.

Additional Information
This placeholder can be used for any achievement in the Advanced Unit of the Supplementary Studies.

T 5.40 Module component: Electrobiotechnology [T-CIWVT-113148]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106518 - Electrobiotechnology

Type	Credits	Grading	Version
Oral examination	4 CP	graded	3

Courses					
WT 25/26	2212010	Electrobiotechnology	2 SWS	Lecture /	Holtmann
WT 25/26	2212011	Electrobiotechnology - Exercises	1 SWS	Seminar /	Holtmann

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-113829 - Electrobiotechnology Seminar must have been passed.

T 5.41 Module component: Electrobiotechnology Seminar [T-CIWVT-113829]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106518 - Electrobiotechnology

Type	Credits	Grading	Version
Examination of another type	2 CP	graded	1

Courses					
WT 25/26	2212010	Electrobiotechnology	2 SWS	Lecture /	Holtmann
WT 25/26	2212011	Electrobiotechnology - Exercises	1 SWS	Seminar /	Holtmann

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

T 5.42 Module component: Electrocatalysis [T-ETIT-111831]

Coordinators: Dr. Philipp Röse
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-105883 - Electrocatalysis

Type	Credits	Grading	Term offered	Version
Written examination	5 CP	graded	Each summer term	2

Courses					
ST 2025	2304300	Electrocatalysis	3 SWS	Lecture / 🗣	Röse
ST 2025	2304301	Exercise to 2304300 Electrocatalysis	1 SWS	Practice / 🗣	Röse

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination takes place in form of a written examination lasting 120 minutes.

T 5.43 Module component: Electrochemistry [T-CHEMBIO-109773]

Organisation: KIT Department of Chemistry and Biosciences
Part of: M-CHEMBIO-106697 - Electrochemistry

Type	Credits	Grading	Term offered	Version
Written examination	3 CP	graded	Irregular	1

Prerequisites
none

T 5.44 Module component: Emulsification Technology [T-CIWVT-114611]

Coordinators: Dr.-Ing. Nico Leister
Dr.-Ing. Ulrike van der Schaaf
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107439 - Emulsification Technology

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

T 5.45 Module component: Energy from Biomass [T-CIWVT-108828]

Coordinators: Dr.-Ing. Siegfried Bajohr
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104288 - Biomass Based Energy Carriers

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each winter term	1

Courses					
WT 25/26	2231510	Biomass Based Energy Carriers	2 SWS	Lecture / 🗣	Bajohr
WT 25/26	2231511	Exercises on 2231510 Biomass Based Energy Carriers	1 SWS	Practice / 🗣	Bajohr, und Mitarbeitende

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.46 Module component: Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics [T-MACH-114731]

Coordinators: apl. Prof. Dr. Alexander Nesterov-Müller
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-107521 - Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2141875	Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics	2 SWS	Lecture / 🗣	Nesterov-Müller

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
written exam Duration of Examination: 50 Minutes

Prerequisites
none

Workload
120 hours

T 5.47 Module component: Excercises: Membrane Technologies [T-CIWVT-113235]

Coordinators: Prof. Dr. Harald Horn
Dr.-Ing. Florencia Saravia
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105380 - Membrane Technologies in Water Treatment

Type	Credits	Grading	Term offered	Version
Coursework	1 CP	pass/fail	Each summer term	1

Courses					
ST 2025	2233011	Membrane Technologies in Water Treatment - Excercises	1 SWS	Practice /	Horn, Saravia, und Mitarbeitende

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
Learning control is a completed coursework: Submission of exercises, membrane design and short presentation (5 minutes, group work).

T 5.48 Module component: Excursions: Water Supply [T-CIWVT-110866]

Coordinators: Prof. Dr. Harald Horn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103440 - Practical Course in Water Technology

Type	Credits	Grading	Term offered	Version
Coursework	1 CP	pass/fail	Each winter term	1

T 5.49 Module component: Extrusion Technology in Food Processing [T-CIWVT-112174]

Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105996 - Extrusion Technology in Food Processing

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2211310	Extrusion Technology in Food Processing	2 SWS	Block / 🗣	Emin

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral exam lasting about 20 minutes.

Prerequisites
None.

T 5.50 Module component: Food Chemistry Basics [T-CHEMBIO-109442]

Coordinators: Prof. Dr. Mirko Bunzel
Organisation: KIT Department of Chemistry and Biosciences
Part of: M-CHEMBIO-104620 - Food Chemistry Basics

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	3

Courses					
ST 2025	6601	Grundlagen der Lebensmittelchemie I	2 SWS	Lecture / 🗣	Bunzel

Legend: 💻 Online, 🎭 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None

T 5.51 Module component: Food Process Engineering [T-CIWVT-114577]

Coordinators: Dr.-Ing. Ulrike van der Schaaf
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107423 - Research Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

T 5.52 Module component: Formulation of (Bio)pharmaceutical Therapeutics [T-CIWVT-108805]

Coordinators: Prof. Dr. Jürgen Hubbuch
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104266 - Formulation of (Bio)pharmaceutical Therapeutics

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2214030	Formulation of (Bio)pharmaceutical Therapeutics	2 SWS	Lecture / 🗣	Hubbuch

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The examination is an oral examination with a duration of about 15 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.53 Module component: Fundamentals of Water Quality [T-CIWVT-106838]

Coordinators: Dr. Michael Wagner
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103438 - Fundamentals of Water Quality

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each winter term	2

Courses					
WT 25/26	2233230	Fundamentals of Water Quality	2 SWS	Lecture / 🗣	Horn, Wagner
WT 25/26	2233231	Fundamentals of Water Quality - Exercises	1 SWS	Practice / 🗣	Wagner, und Mitarbeitende

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control ist an oral exam lasting approx. 20 minutes.

Prerequisites
None.

T 5.54 Module component: Gas Fermentation [T-CIWVT-114612]

Coordinators: Prof. Dr. Nicolaus Dahmen
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107423 - Research Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

T 5.55 Module component: Heat Exchangers [T-CIWVT-108937]

Coordinators: Prof. Dr.-Ing. Thomas Wetzel
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104371 - Heat Exchangers

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each winter term	2

Courses					
WT 25/26	2260010	Heat Exchangers	2 SWS	Lecture /	Wetzel
WT 25/26	2260011	Exercise on 2260010 Heat Exchangers	1 SWS	Practice /	Wetzel

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The examination is an oral examination lasting approx. 20 minutes.

Prerequisites
None

T 5.56 Module component: Hydrogen and Fuel Cell Technologies [T-CIWVT-108836]

Coordinators: Prof. Dr.-Ing. Dimosthenis Trimis
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104296 - Hydrogen and Fuel Cell Technologies

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2232030	Hydrogen and Fuel Cell Technologies	2 SWS	Lecture / 🗣	Trimis

Legend: 📱 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None

T 5.57 Module component: Industrial Aspects in Bioprocess Technology [T-CIWVT-110935]

Coordinators: Prof. Dr. Jürgen Hubbuch
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105412 - Industrial Aspects in Bioprocess Technology

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2214020	Industrial Aspects in Bioprocess Technology	2 SWS	Lecture / 🗣	Hubbuch

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The examination is an oral examination with a duration of about 15 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.58 Module component: Industrial Biocatalysis [T-CIWVT-113432]

Coordinators: PD Dr. Jens Rudat
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106678 - Industrial Biocatalysis

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2212230	Industrial Biocatalysis	2 SWS	Lecture / 🗣	Rudat

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control is an oral exam lasting approx. 20 minutes.

Prerequisites
None

T 5.59 Module component: Industrial Bioprocesses [T-CIWVT-113120]

Coordinators: Prof. Dr.-Ing. Michael-Helmut Kopf
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106501 - Industrial Bioprocesses

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2245810	Industrial Bioprocesses	2 SWS	Lecture /	Kopf

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

Assessment
Learning control is an oral examination with a duration of about 25 minutes.

Prerequisites
None

T 5.60 Module component: Industrial Wastewater Treatment [T-CIWVT-111861]

Coordinators: Prof. Dr. Harald Horn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105903 - Industrial Wastewater Treatment

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	4 CP	graded	Each summer term	1 semesters	1

Courses					
ST 2025	2233020	Industrial Wastewater Treatment	2 SWS	Lecture / 🗣	Horn

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control is an oral examination lasting approx. 20 minutes.

Prerequisites
None

T 5.61 Module component: Innovation Management for Products and Processes in the Chemical Industry [T-CIWVT-108980]

Coordinators: Dr. Claudius Neumann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104397 - Innovation Management for Products & Processes in the Chemical Industry

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each winter term	1

Courses					
ST 2025	2231330	Innovation Management for Products and Processes in the Chemical Industry	2 SWS	Block /	Sauer, Neumann
WT 25/26	2231330	Innovation Management for Products and Processes in the Chemical Industry - Announcement	2 SWS	Block /	Sauer, Neumann

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The examination is a written examination (multiple choice) with a duration of 60 minutes.

Prerequisites
None

T 5.62 Module component: Intensification of Bio-Processes [T-CIWVT-114574]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107423 - Research Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

Prerequisites
None

T 5.63 Module component: Internship [T-CIWVT-114573]

Coordinators: Dr.-Ing. Siegfried Bajohr
Dr.-Ing. Barbara Freudig
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107422 - Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

Prerequisites
None

T 5.64 Module component: Introduction to Numerical Simulation of Reacting Flows [T-CIWVT-113436]

Coordinators: Prof. Dr. Oliver Thomas Stein
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106676 - Introduction to Numerical Simulation of Reacting Flows

Type	Credits	Grading	Version
Oral examination	3 CP	graded	2

Courses					
WT 25/26	2232130	Introduction to Numerical Simulation of Reacting Flows	2 SWS	Lecture / 🗣	Stein
WT 25/26	2232131	Introduction to Numerical Simulation of Reacting Flows - Exercises	2 SWS	Practice / 🗣	Stein

Legend: 💻 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control ist an oral examination lasting approx. 30 minutes.

Prerequisites
The prerequisite must be passed before taking the oral examination.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-113435 - Introduction to Numerical Simulation of Reacting Flows - Prerequisite must have been passed.

T 5.65 Module component: Introduction to Numerical Simulation of Reacting Flows - Prerequisite [T-CIWVT-113435]

Coordinators: Prof. Dr. Oliver Thomas Stein
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106676 - Introduction to Numerical Simulation of Reacting Flows

Type	Credits	Grading	Version
Coursework	5 CP	pass/fail	2

Courses					
WT 25/26	2232130	Introduction to Numerical Simulation of Reacting Flows	2 SWS	Lecture / 🗣	Stein
WT 25/26	2232131	Introduction to Numerical Simulation of Reacting Flows - Exercises	2 SWS	Practice / 🗣	Stein

Legend: 💻 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control is a completed coursework: Reports on the tutorials documenting the processed task, the data generated and their analysis.

Prerequisites
None

T 5.66 Module component: Introduction to Sensory Analysis with Practice [T-CIWVT-109128]

Coordinators: Dr. Heike Hofsäß
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105933 - Introduction to Sensory Analysis

Type	Credits	Grading	Term offered	Version
Examination of another type	2 CP	graded	Each summer term	1

Courses					
ST 2025	6630	Einführung in die Sensorik mit Übungen	1 SWS	Lecture	Hofsäß

Prerequisites
None

T 5.67 Module component: Journal Club - Novel Bioproduction Systems [T-CIWVT-113149]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106526 - Journal Club - Novel Bioproduction Systems

Type	Credits	Grading	Term offered	Version
Examination of another type	4 CP	graded	Each winter term	1

Courses					
ST 2025	2212040	Journal Club – Novel Bioproduction Systems	2 SWS	Seminar / 🗣	Holtmann
WT 25/26	2212040	Journal Club – Novel Bioproduction Systems	2 SWS	Seminar / 🗣	Holtmann

Legend: 📱 Online, 💮 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None.

T 5.68 Module component: Kinetics and Catalysis [T-CIWVT-106032]

Coordinators: Prof. Dr.-Ing. Gregor Wehinger
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104383 - Kinetics and Catalysis

Type	Credits	Grading	Term offered	Version
Written examination	6 CP	graded	Each term	1

Courses					
ST 2025	2220030	Kinetics and Catalysis	2 SWS	Lecture / 🗣	Wehinger
ST 2025	2220031	Kinetics and Catalysis - Exercises	1 SWS	Practice / 🗣	Wehinger, und Mitarbeitende

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is a written examination lasting 60 minutes.

Prerequisites
None

T 5.69 Module component: Laboratory Work for NMR for Engineers [T-CIWVT-109144]

Coordinators: apl. Prof. Dr. Gisela Guthausen
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104401 - NMR for Engineers

Type	Credits	Grading	Term offered	Version
Coursework (practical)	2 CP	pass/fail	Each winter term	1

Courses					
WT 25/26	2245130	NMR for Engineers	2 SWS	Lecture / 🗣	Guthausen
WT 25/26	2245131	Laboratory Work for 2245130 NMR for Engineers	2 SWS	Practical course / 🗣	Guthausen

Legend: 🖥 Online, 🖥🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None

T 5.70 Module component: Lecture Series Supplementary Studies on Science, Technology and Society - Self Registration [T-FORUM-113578]

Coordinators: Dr. Christine Mielke
Christine Myglas
Organisation: General Studies. Forum Science and Society (FORUM)
Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Term offered	Expansion	Version
Coursework	2 CP	pass/fail	Each summer term	1 semesters	1

Assessment
Active participation, learning protocols, if applicable.

Prerequisites
None

Self Service Assignment of Supplementary Studies
This module component can be used for self service assignment of grades acquired from the following study providers:

- Studium Generale. Forum Wissenschaft und Gesellschaft (FORUM) (ehem. ZAK)
- FORUM (ehem. ZAK) Begleitstudium

Recommendations
It is recommended that you complete the lecture series "Science in Society" before attending events in the advanced module and in parallel with attending the basic seminar.
If it is not possible to attend the lecture series and the basic seminar in the same semester, the lecture series can also be attended after attending the basic seminar.
However, attending events in the advanced module before attending the lecture series should be avoided.

Additional Information
The basic module consists of the lecture series "Science in Society" and the basic seminar. The lecture series is only offered during the summer semester.
The basic seminar can be attended in the summer or winter semester.

T 5.71 Module component: Master's Thesis [T-CIWVT-114397]

Coordinators: Prof. Dr. Reinhard Rauch
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107323 - Module Master's Thesis

Type	Credits	Grading	Term offered	Version
Final Thesis	30 CP	graded	Each term	1

Prerequisites
SPO section 14 (1)

The prerequisite for admission to the Master's thesis module is that the student has successfully completed module examinations amounting to 60 CP including the internship in accordance with § 14 a.

Final Thesis
This module component represents a final thesis. The following periods have been supplied:

Submission deadline	6 months
Maximum extension period	3 months
Correction period	8 weeks

This thesis requires confirmation by the examination office.

T 5.72 Module component: Materials and Processes for Electrochemical Storage [T-CIWVT-108146]

Coordinators: Prof. Dr. Jens Tübke
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104353 - Materials and Processes for Electrochemical Storage

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each term	1

Courses					
ST 2025	2245840	Materials and Processes for Electrochemical Storage	2 SWS	Lecture / 🗣	Tübke

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Prerequisites
None

T 5.73 Module component: Membrane Technologies in Water Treatment [T-CIWVT-113236]

Coordinators: Prof. Dr. Harald Horn
Dr.-Ing. Florencia Saravia
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105380 - Membrane Technologies in Water Treatment

Type	Credits	Grading	Term offered	Version
Written examination	5 CP	graded	Each summer term	1

Courses					
ST 2025	2233010	Membrane Technologies in Water Treatment	2 SWS	Lecture / 🗣	Horn, Saravia
ST 2025	2233011	Membrane Technologies in Water Treatment - Excercises	1 SWS	Practice / 🧩	Horn, Saravia, und Mitarbeitende

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an written examination lasting 90 minutes.

Prerequisites
Prerequisite: Submission of exercises, membrane design and short presentation (5 minutes, group work).

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-113235 - Excercises: Membrane Technologies must have been passed.

T 5.74 Module component: Microfluidics [T-CIWVT-108909]

Coordinators: PD Dr. Gero Leneweit
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104350 - Microfluidics

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	2

Courses					
WT 25/26	2245410	Microfluidics - Basics and Applications	2 SWS	Lecture / 🗣	Leneweit

Legend: 💻 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.75 Module component: Microfluidics - Case Studies [T-CIWVT-110549]

Coordinators: PD Dr. Gero Leneweit
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107433 - Microfluidics Lab

Type	Credits	Grading	Term offered	Version
Coursework	2 CP	pass/fail	Each winter term	1

Courses					
WT 25/26	2245411	Case Studies in Microfluidics (Practical Course on 2245410)	1 SWS	Practical course / 🗣	Leneweit

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None

T 5.76 Module component: Microsystems in Bioprocess Engineering [T-CIWVT-114600]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107424 - Microsystems in Bioprocess Engineering

Type	Credits	Grading	Version
Oral examination	4 CP	graded	2

Assessment
Learning control is an oral exam lasting approx. 30 minutes.

Prerequisites
None

T 5.77 Module component: Mixing, Stirring, Agglomeration [T-CIWVT-110895]

Coordinators: Dr.-Ing. Frank Rhein
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105399 - Mixing, Stirring, Agglomeration

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each summer term	1

Courses					
ST 2025	2245310	Mixing, Stirring and Agglomeration	3 SWS	Lecture / 🗣	Rhein

Legend: 📱 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral individual examination with a duration of 30min according SPO section 4, subsection 2.

Prerequisites
None

T 5.78 Module component: Modeling Physiological Systems [T-ETIT-113630]

Coordinators: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106782 - Modeling Physiological Systems

Type	Credits	Grading	Term offered	Version
Written examination	6 CP	graded	Each summer term	1

Assessment
The examination takes place in form of a written examination lasting 90 min.

The module grade is the grade of the written exam.

Prerequisites
"T-ETIT-114690 – Modeling Physiological Systems - Workshop" must be passed in order to register for this written examination.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-ETIT-114690 - Modeling Physiological Systems - Workshop must have been passed.

T 5.79 Module component: Modeling Physiological Systems - Workshop [T-ETIT-114690]

Coordinators: Dr.-Ing. Axel Loewe
Organisation: KIT Department of Electrical Engineering and Information Technology
Part of: M-ETIT-106782 - Modeling Physiological Systems

Type	Credits	Grading	Term offered	Version
Coursework	0 CP	pass/fail	Each summer term	1

Assessment
Success control takes place in the form of ungraded course works. Three workshop tasks must be submitted.

Prerequisites
none

Additional Information
This success control must be passed in order to register for the written examination.

T 5.80 Module component: Molecular Biology and Genetics [T-CHEMBIO-103675]

Coordinators: Prof. Dr. Jörg Kämper
Prof. Dr. Natalia Requena Sanchez
Organisation: KIT Department of Chemistry and Biosciences
Part of: M-CHEMBIO-106204 - Molecular Biology and Genetics

Type	Credits	Grading	Version
Written examination	5 CP	graded	1

Courses					
WT 25/26	7301	Molekularbiologie (BA-04)	2 SWS	Lecture /	Requena Sanchez
WT 25/26	7401	Genetik (BA-04)	2 SWS	Lecture /	Kämper, Kaster

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Prerequisites
none

Workload
150 hours

T 5.81 Module component: Multiscale Bioengineering [T-CIWVT-114576]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107423 - Research Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

T 5.82 Module component: NMR for Engineers [T-CIWVT-108984]

Coordinators: apl. Prof. Dr. Gisela Guthausen
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104401 - NMR for Engineers

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2245130	NMR for Engineers	2 SWS	Lecture / 🗣	Guthausen
WT 25/26	2245131	Laboratory Work for 2245130 NMR for Engineers	2 SWS	Practical course / 🗣	Guthausen

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
Labwork must be passed.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-109144 - Laboratory Work for NMR for Engineers must have been passed.

T 5.83 Module component: NMR Methods for Product and Process Analysis [T-CIWVT-111843]

Coordinators: apl. Prof. Dr. Gisela Guthausen
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105890 - NMR Methods for Product and Process Analysis

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2245130	NMR for Engineers	2 SWS	Lecture / 🗣	Guthausen

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral examination with a duration of about 30 minutes.

Prerequisites
None.

T 5.84 Module component: Nonlinear Process Control [T-CIWVT-112824]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106316 - Nonlinear Process Control

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Courses					
WT 25/26	2243050	Nonlinear Process Control	3 SWS	Lecture / Practice (/	Meurer

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Prerequisites
None.

T 5.85 Module component: Numerical Simulation of Reacting Multiphase Flows [T-CIWVT-114118]

Coordinators: Prof. Dr. Oliver Thomas Stein
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107076 - Numerical Simulation of Reacting Multiphase Flows

Type	Credits	Grading	Version
Oral examination	3 CP	graded	1

Courses					
ST 2025	2232120	Numerical Simulation of Reacting Multiphase Flows	2 SWS	Lecture / 🗣	Stein
ST 2025	2232121	Numerical Simulation of Reacting Multiphase Flows - Exercises	2 SWS	Practice / 🗣	Stein, und Mitarbeitende

Legend: 📱 Online, 🌀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control ist an oral examination lasting approx. 30 minutes.

Prerequisites
The prerequisite must be passed before taking the oral examination.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-114117 - Numerical Simulation of Reacting Multiphase Flows - Prerequisite must have been passed.

T 5.86 Module component: Numerical Simulation of Reacting Multiphase Flows - Prerequisite [T-CIWVT-114117]

Coordinators: Prof. Dr. Oliver Thomas Stein
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107076 - Numerical Simulation of Reacting Multiphase Flows

Type	Credits	Grading	Version
Coursework	5 CP	pass/fail	1

Courses					
ST 2025	2232120	Numerical Simulation of Reacting Multiphase Flows	2 SWS	Lecture / 🗣	Stein
ST 2025	2232121	Numerical Simulation of Reacting Multiphase Flows - Exercises	2 SWS	Practice / 🗣	Stein, und Mitarbeitende

Legend: 📱 Online, 🌀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control is a completed coursework: Reports on the tutorials documenting the processed task, the data generated and their analysis.

Prerequisites
None

T 5.87 Module component: Optimal and Model Predictive Control [T-CIWVT-112825]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106317 - Optimal and Model Predictive Control

Type	Credits	Grading	Version
Oral examination	6 CP	graded	1

Courses					
ST 2025	2243030	Optimal and Model Predictive Control	2 SWS	Lecture / 🗣	Meurer
ST 2025	2243031	Optimal and Model Predictive Control - Exercises	1 SWS	Practice / 🗣	Meurer

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 5.88 Module component: Organ Support Systems [T-MACH-105228]

Coordinators: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102702 - Organ Support Systems

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each summer term	2

Courses					
ST 2025	2106008	Organ support systems	2 SWS	Lecture / 🗣	Pylatiuk

Legend: 📱 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written examination (Duration: 60 min)

Prerequisites
none

Additional Information
The course is offered in German.

Workload
120 hours

T 5.89 Module component: Parallel Computing [T-MATH-102271]

Coordinators: PD Dr. Mathias Krause
Prof. Dr. Christian Wieners
Organisation: KIT Department of Mathematics
Part of: M-MATH-101338 - Parallel Computing

Type	Credits	Grading	Version
Oral examination	5 CP	graded	1

T 5.90 Module component: Particle Technology Exam [T-CIWVT-106028]

Coordinators: Prof. Dr.-Ing. Achim Dittler
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104378 - Particle Technology

Type	Credits	Grading	Version
Written examination	6 CP	graded	1

Courses					
ST 2025	2244030	Particle Technology	2 SWS	Lecture / 🗣	Dittler
ST 2025	2244031	Particle Technology - Exercises	1 SWS	Practice / 🗣	Dittler, und Mitarbeitende

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is a written examination lasting 120 minutes.

Prerequisites
None

T 5.91 Module component: Plant an System Design [T-CIWVT-114537]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Prof. Dr.-Ing. Dirk Holtmann

Organisation: KIT Department of Chemical and Process Engineering

Part of: M-CIWVT-107402 - Plant and System Design

Type	Credits	Grading	Term offered	Version
Examination of another type	6 CP	graded	Each term	1

Courses					
WT 25/26	2210030	Plant and System Design	3 SWS	Project (P / 🗣	Holtmann, Grünberger

Legend: 📱 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 5.92 Module component: Practical Course in Water Technology [T-CIWVT-106840]

Coordinators: Dr. Andrea Hille-Reichel
Prof. Dr. Harald Horn

Organisation: KIT Department of Chemical and Process Engineering

Part of: M-CIWVT-103440 - Practical Course in Water Technology

Type	Credits	Grading	Term offered	Version
Examination of another type	3 CP	graded	Each winter term	4

Courses					
WT 25/26	2233032	Practical Course: Water Quality and Water Assessment	2 SWS	Practical course / 🗣	Horn, Hille-Reichel, und Mitarbeitende

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control is an examination of another type:
6 Experiments including entrance test, protocol; presentation about a selected experiment (about 15 minutes); final test.

Prerequisites
Participation in the excursion, report.

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module M-CIWVT-103407 - Water Technology must have been started.
2. The module component T-CIWVT-110866 - Excursions: Water Supply must have been passed.

T 5.93 Module component: Practical in Additive Manufacturing for Process Engineering [T-CIWVT-110903]

Coordinators: TT-Prof. Dr. Christoph Klahn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105407 - Additive Manufacturing for Process Engineering

Type	Credits	Grading	Version
Coursework (practical)	1 CP	pass/fail	1

Courses					
ST 2025	2241021	Practical in Additive Manufacturing for Process Engineering	1 SWS	Practical course / 🗣	Klahn

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

T 5.94 Module component: Principles of Constrained Static Optimization [T-CIWVT-112811]

Coordinators: Dr.-Ing. Pascal Jerono
Prof. Dr.-Ing. Thomas Meurer

Organisation: KIT Department of Chemical and Process Engineering

Part of: M-CIWVT-106313 - Principles of Constrained Static Optimization

Type	Credits	Grading	Version
Oral examination	4 CP	graded	1

Courses					
WT 25/26	2243060	Principles of Constrained Static Optimization	2 SWS	Lecture / Practice (/ 🗣	Meurer, Jerono

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

T 5.95 Module component: Principles of Medicine for Engineers [T-MACH-105235]

Coordinators: apl. Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102720 - Principles of Medicine for Engineers

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each winter term	2

Courses					
WT 25/26	2105992	Principles of Medicine for Engineers	2 SWS	Lecture / 🗣	Pylatiuk

Legend: 📱 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Written examination (Duration: 60 min)

Prerequisites
none

Additional Information
The course is offered in German.

Workload
120 hours

T 5.96 Module component: Printed and Thin-Film Electronics [T-ETIT-114417]

Coordinators: Prof. Dr. Jasmin Aghassi-Hagmann
Dr. Dr. Michael Hirtz

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-107343 - Printed and Thin-Film Electronics

Type	Credits	Grading	Term offered	Version
Oral examination	3 CP	graded	Each winter term	1

Courses					
WT 25/26	2308480	Printed and Thin-Film Electronics	2 SWS	Lecture /	Aghassi-Hagmann, Hirtz

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The assessment takes place in form of an oral examination (approx. 20 minutes).

Prerequisites
none

T 5.97 Module component: Process Analysis: Modeling, Data Mining, Machine Learning [T-ETIT-111214]

Coordinators: Dr.-Ing. Christian Borchert
Prof. Dr.-Ing. Michael Heizmann

Organisation: KIT Department of Electrical Engineering and Information Technology

Part of: M-ETIT-105594 - Process Analysis: Modeling, Data Mining, Machine Learning

Type	Credits	Grading	Term offered	Expansion	Version
Oral examination	3 CP	graded	Each summer term	1 semesters	2

Courses					
ST 2025	2302145	Process Analysis: Modeling, Data Mining, Machine Learning	2 SWS	Lecture / 🗣	Borchert

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 5.98 Module component: Process and Plant Design in Biotechnology - Seminar [T-CIWVT-114498]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107357 - Process and Plant Design in Biotechnology

Type	Credits	Grading	Term offered	Version
Examination of another type	2 CP	graded	Each summer term	1

Courses					
WT 25/26	2212020	Process and Plant Design in Biotechnology	2 SWS	Lecture / 🗣	Holtmann
WT 25/26	2212021	Exercises on 2212020 Process and Plant Design in Biotechnology	1 SWS	Seminar / 🗣	Holtmann

Legend: 💻 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Examination of another type: Seminar talk lasting approx. 10 minutes.

Prerequisites
None

T 5.99 Module component: Process and Plant Design in Biotechnology - Written Exam [T-CIWVT-114499]

Coordinators: Prof. Dr.-Ing. Dirk Holtmann
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107357 - Process and Plant Design in Biotechnology

Type	Credits	Grading	Term offered	Version
Written examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2212020	Process and Plant Design in Biotechnology	2 SWS	Lecture / 🗣	Holtmann
WT 25/26	2212021	Exercises on 2212020 Process and Plant Design in Biotechnology	1 SWS	Seminar / 🗣	Holtmann

Legend: 📱 Online, 🌐 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is a written examination lasting 90 minutes.

Prerequisites
Seminar

Modeled Prerequisites
The following conditions have to be fulfilled:

1. The module component T-CIWVT-114498 - Process and Plant Design in Biotechnology - Seminar must have been passed.

Recommendations
Knowledge in biochemistry, genetics, cell biology, microbiology and bioprocess engineering is required.

T 5.100 Module component: Process and Plant Safety [T-CIWVT-108912]

Coordinators: Hon.-Prof. Dr. Jürgen Schmidt
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104352 - Process and Plant Safety

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2231810	Process and Plant Safety	2 SWS	Lecture / 🗣	Schmidt

Legend: Online, Blended (On-Site/Online), 🗣 On-Site, × Cancelled

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.101 Module component: Process Engineering for the Production of Food from Animal Origins [T-CIWVT-113477]

Coordinators: PD Dr. Volker Gaukel
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106699 - Process Engineering for the Production of Food from Animal Origins

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2211010	Process Engineering for the Production of Food from Animal Origins	2 SWS	Lecture / 🗣	Gaukel

Legend: 📱 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The learning control is an oral examination lasting approx. 30 minutes.

Prerequisites
None

T 5.102 Module component: Process Engineering for the Production of Food from Plant-Based Raw Materials [T-CIWVT-113476]

Coordinators: Dr.-Ing. Ulrike van der Schaaf
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106698 - Process Engineering for the Production of Food from Plant-Based Raw Materials

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2211010	Process Engineering for the Production of Food From Plant-Based Raw Materials	2 SWS	Lecture /	van der Schaaf

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The examination is an oral examination with a duration of about 30 minutes.

Prerequisites
None

T 5.103 Module component: Process Instruments and Machinery and Their Process Integration [T-CIWVT-108910]

Coordinators: Dr.-Ing. Manfred Nagel
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104351 - Process Instruments and Machinery and Their Process Integration

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2245820	Process Instruments and Machinery and Their Process Integration	2 SWS	Block / 🗣	Nagel

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The examination is an oral examination with a duration of about 30 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.104 Module component: Process Modeling in Downstream Processing [T-CIWVT-106101]

Coordinators: apl. Prof. Dr. Matthias Franzreb
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103066 - Process Modeling in Downstream Processing

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
ST 2025	2214110	Process Modeling in Downstream Processing	2 SWS	Lecture / 🗣	Franzreb

Legend: 🖳 Online, 🖳🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None

T 5.105 Module component: Processes and Process Chains for Renewable Resources [T-CIWVT-108997]

Coordinators: Prof. Dr. Nicolaus Dahmen
Prof. Dr.-Ing. Jörg Sauer

Organisation: KIT Department of Chemical and Process Engineering

Part of: M-CIWVT-104422 - Processes and Process Chains for Renewable Resources

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each summer term	1

Courses					
ST 2025	2231210	Processes and Process Chains for Renewable Resources	3 SWS	Lecture / Practice (/ 🗣	Dahmen, Sauer

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
Learning control is an oral examination lasting approx. 20 minutes.

Prerequisites
None

T 5.106 Module component: Processing of Nanostructured Particles [T-CIWVT-106107]

Coordinators: Prof. Dr.-Ing. Hermann Nirschl
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103073 - Processing of Nanostructured Particles

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each winter term	1

Courses					
WT 25/26	2245030	Processing of Nanostructured Particles	2 SWS	Lecture / 🗣	Nirschl

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None

T 5.107 Module component: Production and Development of Cancer Therapeutics [T-CIWVT-113230]

Coordinators: PD Dr. Gero Leneweit
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106563 - Production and Development of Cancer Therapeutics

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2245420	Production and Development of Cancer Therapeutics	2 SWS	Lecture / 🗣	Leneweit

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
Learning control is an oral examination lasting approx. 30 minutes.

Prerequisites
None

T 5.108 Module component: Reactor Modeling with CFD [T-CIWVT-113224]

Coordinators: Prof. Dr.-Ing. Gregor Wehinger
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106537 - Reactor Modeling with CFD

Type	Credits	Grading	Version
Examination of another type	4 CP	graded	1

Courses					
ST 2025	2220060	Reactor Modeling with CFD	1 SWS	Lecture /	Wehinger, Reinold
ST 2025	2220061	Exercise Reactor Modeling with CFD	2 SWS	Practice /	Wehinger, und Mitarbeitende

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Prerequisites
None.

T 5.109 Module component: Refinery Technology - Liquid Fuels [T-CIWVT-108831]

Coordinators: Prof. Dr. Reinhard Rauch
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104291 - Refinery Technology - Liquid Fuels

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each summer term	1

Courses					
ST 2025	2231120	Refinery Technology - Liquid Fuels	2 SWS	Lecture / 🗣	Rauch
ST 2025	2231121	Refinery Technology - Exercises	1 SWS	Practice / 🗣	Rauch, und Mitarbeitende

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.110 Module component: Registration for Certificate Issuance - Supplementary Studies on Science, Technology and Society [T-FORUM-113587]

Coordinators: Dr. Christine Mielke
Christine Myglas

Organisation: General Studies. Forum Science and Society (FORUM)

Part of: M-FORUM-106753 - Supplementary Studies on Science, Technology and Society

Type	Credits	Grading	Term offered	Version
Coursework	0 CP	pass/fail	Each term	1

Prerequisites
In order to register, it is mandatory that the basic module and the advanced module have been completed and that the grades for the partial performances in the advanced module are available.

Registration as a partial achievement means the issue of a certificate.

T 5.111 Module component: Rheology of Polymers [T-CIWVT-108884]

Coordinators: Prof. Dr. Norbert Willenbacher
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104329 - Rheology of Polymers

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each summer term	1

Courses					
ST 2025	2242050	Rheology of Polymers	2 SWS	Lecture / 🗣	Willenbacher

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 30 minutes.

Prerequisites
None

T 5.112 Module component: Seminar of Food Processing in Practice with Excursion [T-CIWVT-109129]

Coordinators: Dr.-Ing. Nico Leister
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-105932 - Seminar of Food Processing in Practice

Type	Credits	Grading	Term offered	Version
Oral examination	2 CP	graded	Each winter term	3

Courses					
WT 25/26	2211930	Seminar Food Processing in Practice, incl. Excursion	3 SWS	Block / 🗣	Leister, Ellwanger, Martin, van der Schaaf

Legend: 💻 Online, 🏫 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral exam with a duration of about 20 minutes.

Prerequisites
None

T 5.113 Module component: Simulation Technologies - Exam [T-CIWVT-114104]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107038 - Simulation Technologies

Type	Credits	Grading	Version
Oral examination	3 CP	graded	1

Courses					
ST 2025	2243090	Simulation Methods for Dynamic Systems	2 SWS	Lecture / 🗣	Meurer, Jerono
ST 2025	2243091	Simulation Methods for Dynamic Systems - Exercises	1 SWS	Practice / 🗣	Meurer, Jerono

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
Learning control is an oral examination lasting approx. 45 minutes.

Prerequisites
The prerequisite must be past.

T 5.114 Module component: Simulation Technologies - Prerequisite [T-CIWVT-114141]

Coordinators: Prof. Dr.-Ing. Thomas Meurer
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107038 - Simulation Technologies

Type	Credits	Grading	Version
Examination of another type	3 CP	graded	1

Assessment
Learning control is an examination of another type:
Written elaboration on a programming task.

T 5.115 Module component: Single-Cell Technologies [T-CIWVT-113231]

Coordinators: Prof. Dr.-Ing. Alexander Grünberger
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-106564 - Single-Cell Technologies

Type	Credits	Grading	Version
Oral examination	4 CP	graded	1

Courses					
WT 25/26	2213030	Single-Cell Technologies	2 SWS	Lecture /	Grünberger

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

Assessment
The learning control is an oral examination.

Prerequisites
None

T 5.116 Module component: Solid Liquid Separation [T-CIWVT-108897]

Coordinators: Dr.-Ing. Marco Gleiß
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104342 - Solid Liquid Separation

Type	Credits	Grading	Term offered	Version
Oral examination	8 CP	graded	Each winter term	1

Courses					
WT 25/26	2245230	Mechanical Separation Technology	3 SWS	Lecture / 🗣	Gleiß
WT 25/26	2245231	Exercises for 2245230 Mechanical Separation Technology	1 SWS	Practice / 🗣	Gleiß

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of 30 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.117 Module component: Stability of Disperse Systems [T-CIWVT-108885]

Coordinators: Prof. Dr. Norbert Willenbacher
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-104330 - Stability of Disperse Systems

Type	Credits	Grading	Term offered	Version
Oral examination	4 CP	graded	Each winter term	1

Courses					
WT 25/26	2242030	Stability of Disperse Systems	2 SWS	Lecture / 🗣	Willenbacher

Legend: 📱 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Assessment
The examination is an oral examination with a duration of about 20 minutes (section 4 subsection 2 number 2 SPO).

Prerequisites
None

T 5.118 Module component: Thermal Process Engineering II [T-CIWVT-114107]

Coordinators: Prof. Dr.-Ing. Tim Zeiner
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107039 - Thermal Process Engineering II

Type	Credits	Grading	Version
Written examination	6 CP	graded	1

Courses					
ST 2025	2260150	Thermal Process Engineering II	2 SWS	Lecture / 🗣	Zeiner
ST 2025	2260151	Thermal Process Engineering - Exercises	2 SWS	Practice / 🗣	Zeiner, und Mitarbeitende

Legend: 🖥 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

Prerequisites
None.

T 5.119 Module component: Thermal Process Engineering III [T-CIWVT-114108]

Coordinators: Prof. Dr.-Ing. Tim Zeiner
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107040 - Thermal Process Engineering III

Type	Credits	Grading	Term offered	Version
Examination of another type	6 CP	graded	Each winter term	1

Courses					
WT 25/26	2260120	Thermal Process Engineering III	2 SWS	Lecture / 🗣	Zeiner
WT 25/26	2260121	Exercises for 2260120 Thermal Process Engineering III	2 SWS	Practice / 🗣	Zeiner, und Mitarbeitende

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

T 5.120 Module component: Thermodynamics for Bioengineering [T-CIWVT-114497]

Coordinators: Prof. Dr. Sabine Enders
Prof. Dr.-Ing. Tim Zeiner

Organisation: KIT Department of Chemical and Process Engineering

Part of: M-CIWVT-107386 - Thermodynamics for Bioengineering

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each summer term	1

Prerequisites
None.

Recommendations
Thermodynamics II.

T 5.121 Module component: Water Technology [T-CIWVT-114614]

Coordinators: Prof. Dr. Harald Horn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-107423 - Research Internship

Type	Credits	Grading	Term offered	Version
Coursework (practical)	12 CP	pass/fail	Each term	1

T 5.122 Module component: Water Technology [T-CIWVT-106802]

Coordinators: Prof. Dr. Harald Horn
Organisation: KIT Department of Chemical and Process Engineering
Part of: M-CIWVT-103407 - Water Technology

Type	Credits	Grading	Term offered	Version
Oral examination	6 CP	graded	Each winter term	1

Courses					
WT 25/26	2233030	Water Technology	2 SWS	Lecture / 🗣	Horn
WT 25/26	2233031	Exercises to Water Technology	1 SWS	Practice / 🗣	Horn, und Mitarbeitende

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled