Karlsruher Institut für Technologie

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

SPO 2025

Winter semester 2026/27

Date: 09/09/2026

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**<br>www.ciw.kit.edu<br>**Department**<br>https://www.ciw.kit.edu<br>**Business unit Studium und Lehre**<br>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

## 1.4 Studies and Examination Regulations

The legal basis for the degree program and all examinations in the degree program is the *"Study and Examination Regulations of the Karlsruhe Institute of Technology (KIT) for the Master's degree program in Bioengineering"* dated 21 May 2025.

https://www.sle.kit.edu/downloads/AmtlicheBekanntmachungen/2025-AB-033.pdf

## 1.5 Organizational issues

Recognition of achievements according to § 18 SPO

A request for recognition of achievements that habe been completed

- At another university
- abroad
- within the scope of the master transfer account
- outside the higher education system

can be submitted to the Master's Examination Board (Ms. Gärtner) within one semester. There, if necessary after consultation with the subject representative, it will be determined whether the performance is equivalent to a performance envisaged in the curriculum of the course of study and can be recognised. Achievements completed as part of a semester abroad can also be recognized at a later date. If you have already completed a work placement or an practical semester, you can aks for recognition directly to the Internship Office (Ms. Gärtner).

Registering for examinations in the elective areas

Before registering for module examinations in the specializations as well as the areas of process engineering and computer-aided methods, a study plan must be submitted to the Master's Examination Board (Ms Gärtner) for approval. Only then the modules are added to the study schedule and online registration in the student portal is possible. For more information, see the faculty website at
https://www.ciw.kit.edu/english/1667.php
Subsequent changes to the curriculum must also be requested from Ms. Gärtner.

Additional achievements and interdisciplinary qualifications

Additional credits and interdisciplinary qualifications cannot always be registered directly in the CAS system (e.g. some modules from another faculty). In any case, you must contact the Master's Examination Board (Ms. Gärtner) BEFORE the examination.

Exception:
Interdisciplinary qualification at the House of Competence (HoC), Language Center (SPZ) or Forum for Science and Society (FORUM)

If the Soft Skill Qualification is taken at the HoC or Language Centre or FORUM, then no certificate of approval is required for an examination achievement, as the achievements are automatically posted in the CAS system under "unallocated credits". If you want to credit an achievement that is listed under " unallocated credits", you have submit a form to the Masters
Examination Board. For forms, please refer to the website of the KIT Faculty of Chemical and Process Engineering
https://www.ciw.kit.edu/english/3318.php

**Overview: Fields and Modules**

| Field | Module | Responsible | CP |
|---|---|---|---|
| Core Skills<br>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)<br>Remaining credits: e. g. offers of the House of Competence of FORUM | | 4 |
| Computer-aided Methods<br>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.<br>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.<br>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).<br>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

# MODULE IN ENGLISCHER SPRACHE

(English Courses)

| | | |
|---|---|---|
| • Additive Manufacturing for Process Engineering | 6 LP | SS |
| • Advanced Scientific Methods | 2 LP | SS |
| • Alternative Protein Technologies | 4 LP | SS |
| • Batteries, Fuel Cells and Electrolysis | 6 LP | WS |
| • Biofilm Systems | 4 LP | SS |
| • Bioprocess Scale-Up | 6 LP | WS |
| • Biosensors | 4 LP | SS/WS |
| • Computational Fluid Dynamics and Simulation Lab | 4 LP | SS |
| • Data-Based Modeling and Control | 6 LP | WS |
| • Deep Learning and Neural Networks | 6 LP | SS |
| • Digital Design in Process Engineering | 6 LP | WS |
| • Electrocatalysis | 6 LP | SS |
| • Extrusion Technology in Food Processing | 4 LP | WS |
| • Fundamentals of Water Quality | 6 LP | WS |
| • Industrial Wastewater Treatment | 4 LP | SS |
| • Innovation Management for Products and Processes | 4 LP | SS |
| in the Chemical Industry | 6 LP | WS |
| • Introduction to Numerical Simulation of Reacting Flows | 8 LP | WS |
| • Membrane Technologies in Water Treatment | 6 LP | SS |
| • Microsystems in Bioprocess Engineering | 4 LP | SS |
| • Modeling Physiological Systems | 6 LP | SS |
| • Multimodal Artificial Intelligence | 6 LP | SS |
| • Nonlinear Process Control | 6 LP | WS |
| • Numerical Simulation of Reacting Multiphase Flows | 8 LP | SS |
| • Optimal and Model Predictive Control | 6 LP | SS |
| • Practical Course in Water Technology | 4 LP | WS |
| • Principles of Constrained Static Optimization | 4 LP | WS |
| • Reactor Modeling with CFD | 4 LP | SS |
| • Single-Cell Technologies | 4 LP | WS |
| • Water Technology | 6 LP | WS |

# 4 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 (Elective: 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 valid SoSe 26 | **4 CP** |
| **Voluntary** | |
| Additional Achievements<br>***This field will not influence the calculated grade of its parent.*** | |

## 4.1 Master's Thesis

**Credits**
30

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **M-CIWVT-107323** | Master's Thesis | **DE/EN** | **WT+ST** | **30 CP** |

## 4.2 Core Skills

**Credits**
12

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **M-CIWVT-107357** | Process and Plant Design in Biotechnology | **DE** | **WT** | **6 CP** |
| **M-CIWVT-107386** | Thermodynamics for Bioengineering | **DE** | **ST** | **6 CP** |

## 4.3 Process Engineering

**Credits**
6-16

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Process Engineering (Elective: between 6 and 16 credits)** | | | | |
| **M-CIWVT-105407** | Additive Manufacturing for Process Engineering | **EN** | **ST** | **6 CP** |
| **M-CIWVT-105782** | Digital Design in Process Engineering | **EN** | **WT** | **6 CP** |
| **M-CIWVT-107037** | Dynamics of Process Engineering Systems | **DE** | **ST** | **6 CP** |
| **M-CIWVT-107653** | Electrification of the Process Industry | **DE** | **ST** | **4 CP** |
| **M-CIWVT-107439** | Emulsification Technology | **DE** | **ST** | **4 CP** |
| **M-CIWVT-104342** | Solid Liquid Separation | **DE** | **WT** | **8 CP** |
| **M-CIWVT-104383** | Kinetics and Catalysis | **DE** | **ST** | **6 CP** |
| **M-CIWVT-104353** | Materials and Processes for Electrochemical Storage | **DE** | **WT+ST** | **4 CP** |
| **M-CIWVT-105399** | Mixing, Stirring, Agglomeration | **DE** | **ST** | **6 CP** |
| **M-CIWVT-104378** | Particle Technology | **DE** | **ST** | **6 CP** |
| **M-CIWVT-104291** | Refinery Technology - Liquid Fuels | **DE** | **ST** | **6 CP** |
| **M-CIWVT-104329** | Rheology of Polymers | **DE** | **ST** | **4 CP** |
| **M-CIWVT-104352** | Process and Plant Safety | **DE** | **ST** | **4 CP** |
| **M-CIWVT-104330** | Stability of Disperse Systems | **DE** | **WT** | **4 CP** |
| **M-CIWVT-107039** | Thermal Process Engineering II | **DE** | **ST** | **6 CP** |
| **M-CIWVT-107040** | Thermal Process Engineering III | **DE** | **WT** | **6 CP** |
| **M-CIWVT-103073** | Processing of Nanostructured Particles | **DE** | **WT** | **6 CP** |
| **M-CIWVT-104351** | Process Instruments and Machinery and Their Process Integration | **DE** | **WT** | **4 CP** |
| **M-CIWVT-104371** | Heat Exchangers | **DE** | **WT** | **6 CP** |
| **M-CIWVT-104296** | Hydrogen and Fuel Cell Technologies | **DE** | **ST** | **4 CP** |

## 4.4 Computer-aided Methods

**Credits**
6-16

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Computer-aided Methods (Elective: between 6 and 16 credits)** | | | | |
| **M-MATH-106634** | Computational Fluid Dynamics and Simulation Lab | **DE/EN** | **ST** | **4 CP** |
| **M-CIWVT-106319** | Data-Based Modeling and Control | **EN** | **WT** | **6 CP** |
| **M-CIWVT-106835** | Data-Driven Process Engineering Models in Python | **DE** | **WT** | **4 CP** |
| **M-INFO-107197** | Deep Learning and Neural Networks | **EN** | **ST** | **6 CP** |
| **M-CIWVT-104973** | Digitization in Particle Technology | **DE** | **WT** | **6 CP** |
| **M-INFO-106014** | Introduction to Artificial Intelligence | **DE** | **WT** | **6 CP** |
| **M-CIWVT-106676** | Introduction to Numerical Simulation of Reacting Flows | **EN** | **WT** | **8 CP** |
| **M-ETIT-106782** | Modeling Physiological Systems | **EN** | **ST** | **6 CP** |
| **M-INFO-107676** | Multimodal Artificial Intelligence | **EN** | **ST** | **6 CP** |
| **M-CIWVT-106316** | Nonlinear Process Control | **EN** | **WT** | **6 CP** |
| **M-CIWVT-107076** | Numerical Simulation of Reacting Multiphase Flows | **EN** | **ST** | **8 CP** |
| **M-CIWVT-103072** | Computational Fluid Dynamics | **DE** | **WT** | **6 CP** |
| **M-CIWVT-106317** | Optimal and Model Predictive Control | **EN** | **ST** | **6 CP** |
| **M-MATH-101338** | Parallel Computing | **DE/EN** | **Irreg.** | **6 CP** |
| **M-CIWVT-106313** | Principles of Constrained Static Optimization | **EN** | **WT** | **4 CP** |
| **M-ETIT-105594** | Process Analysis: Modeling, Data Mining, Machine Learning | **DE** | **ST** | **3 CP** |
| **M-CIWVT-106537** | Reactor Modeling with CFD | **EN** | **ST** | **6 CP** |

## 4.5 Specialization: Biopharmaceutical Process Engineering

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-107629** | Biopharmaceutical Purification Processes | **DE** | **WT** | **6 CP** |
| **M-CIWVT-105412** | Industrial Aspects in Bioprocess Technology | **DE** | **ST** | **4 CP** |
| **M-CIWVT-103066** | Process Modeling in Downstream Processing | **DE** | **ST** | **4 CP** |
| **M-CIWVT-106563** | Production and Development of Cancer Therapeutics | **DE** | **WT** | **4 CP** |
| **M-CIWVT-104329** | Rheology of Polymers | **DE** | **ST** | **4 CP** |
| **M-CIWVT-105399** | Mixing, Stirring, Agglomeration | **DE** | **ST** | **6 CP** |

## 4.6 Specialization: Health Technology

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-107629** | Biopharmaceutical Purification Processes | **DE** | **WT** | **6 CP** |
| **M-CIWVT-104266** | Formulation of (Bio)pharmaceutical Therapeutics | **DE** | **WT** | **4 CP** |
| **M-MACH-102720** | Principles of Medicine for Engineers | **DE** | **WT** | **4 CP** |
| **M-MACH-102702** | Organ Support Systems | **DE** | **ST** | **4 CP** |
| **M-CIWVT-106838** | Biosensors | **EN** | **WT+ST** | **4 CP** |
| **M-ETIT-106782** | Modeling Physiological Systems | **EN** | **ST** | **6 CP** |
| **M-ETIT-107343** | Printed and Thin-Film Electronics | **EN** | **WT** | **3 CP** |
| **M-MACH-107521** | Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics | **EN** | **WT** | **4 CP** |

## 4.7 Specialization: Industrial Biotechnology

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-107402** | Plant and System Design | **DE** | **WT+ST** | **6 CP** |
| **M-CIWVT-106837** | Bioprocess Scale-up | **EN** | **WT** | **6 CP** |
| **M-CIWVT-106501** | Industrial Bioprocesses | **DE** | **WT** | **4 CP** |
| **M-CIWVT-106678** | Industrial Biocatalysis | **DE** | **ST** | **4 CP** |
| **M-CIWVT-104273** | Commercial Biotechnology | **DE** | **ST** | **4 CP** |
| **M-CIWVT-106595** | Bioreactor Development | **DE** | **ST** | **4 CP** |

## 4.8 Specialization: Design of Food Products

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-107439** | Emulsification Technology | **DE** | **ST** | **4 CP** |
| **M-CIWVT-104388** | Development of an Innovative Food Product | **DE** | **WT+ST** | **6 CP** |
| **M-CHEMBIO-104620** | Food Chemistry Basics | **DE** | **ST** | **4 CP** |
| **M-CIWVT-106661** | Alternative Protein Technologies | **EN** | **ST** | **4 CP** |
| **M-CIWVT-105933** | Introduction to Sensory Analysis | **DE** | **ST** | **2 CP** |
| **M-WIWI-107905** | Managing the Marketing Mix<br>***First usage possible from Apr 01, 2027.*** | **DE** | **ST** | **4 CP** |
| **M-WIWI-107904** | B2B Sales Management | **DE** | **WT** | **4 CP** |

## 4.9 Specialization: Food Process Engineering

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-106698** | Process Engineering for the Production of Food from Plant-Based Raw Materials | **DE** | **WT** | **4 CP** |
| **M-CIWVT-106699** | Process Engineering for the Production of Food from Animal Origins | **DE** | **ST** | **4 CP** |
| **M-CIWVT-105996** | Extrusion Technology in Food Processing | **EN** | **WT** | **4 CP** |
| **M-CIWVT-107679** | Food Processing in Practice | **DE** | **WT** | **2 CP** |
| **M-CIWVT-107439** | Emulsification Technology | **DE** | **ST** | **4 CP** |
| **M-CIWVT-104330** | Stability of Disperse Systems | **DE** | **WT** | **4 CP** |

## 4.10 Specialization: Micro-Bioprocess Engineering

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-107424** | Microsystems in Bioprocess Engineering | **EN** | **ST** | **4 CP** |
| **M-CIWVT-104350** | Microfluidics | **DE** | **WT** | **4 CP** |
| **M-CIWVT-107433** | Microfluidics Lab | **DE** | **WT** | **2 CP** |
| **M-CIWVT-106564** | Single-Cell Technologies | **EN** | **WT** | **4 CP** |
| **M-MACH-100489** | BioMEMS - Microsystems Technologies for Life Sciences and Medicine I | **DE** | **WT** | **4 CP** |
| **M-MACH-100490** | BioMEMS - Microsystems Technologies for Life Sciences and Medicine II | **DE** | **ST** | **4 CP** |
| **M-MACH-100491** | BioMEMS - Microsystems Technologies for Life Sciences and Medicine III | **DE** | **ST** | **4 CP** |
| **M-MACH-105483** | BioMEMS - Microsystemtechnolgy for Life-Science and Medicine IV | **DE/EN** | **WT** | **4 CP** |

## 4.11 Specialization: New Bio-Production Systems - Electro-Biotechnology

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-106518** | Electrobiotechnology | **DE** | **ST** | **6 CP** |
| **M-CIWVT-106816** | C1-Biotechnology | **DE** | **WT** | **6 CP** |
| **M-CHEMBIO-106204** | Molecular Biology and Genetics | **DE** | **WT** | **5 CP** |
| **M-ETIT-105883** | Electrocatalysis | **EN** | **ST** | **6 CP** |
| **M-CHEMBIO-106697** | Electrochemistry | **DE** | **Irreg.** | **3 CP** |
| **M-ETIT-107005** | Batteries, Fuel Cells, and Electrolysis | **EN** | **WT** | **6 CP** |

## 4.12 Specialization: Conversion of Renewable Resources

**Credits**
10-20

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

## 4.13 Specialization: Water Technology

**Credits**
10-20

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: between 10 and 20 credits)** | | | | |
| **M-CIWVT-103407** | Water Technology | **EN** | **WT** | **6 CP** |
| **M-CIWVT-103438** | Fundamentals of Water Quality | **EN** | **WT** | **6 CP** |
| **M-CIWVT-105903** | Industrial Wastewater Treatment | **EN** | **ST** | **4 CP** |
| **M-CIWVT-105380** | Membrane Technologies in Water Treatment | **EN** | **ST** | **6 CP** |
| **M-CIWVT-103440** | Practical Course in Water Technology | **EN** | **WT** | **4 CP** |
| **M-CIWVT-103441** | Biofilm Systems | **EN** | **ST** | **4 CP** |
| **M-CIWVT-104401** | NMR for Engineers | **DE** | **WT** | **6 CP** |
| **M-CIWVT-105890** | NMR Methods for Product and Process Analysis | **DE/EN** | **WT** | **4 CP** |

## 4.14 Internship

**Credits**
12

**Election notes**
The following options are available:

- Internship in industry or at an external research institution, duration at least 12 weeks
- Research internship at an institute at KIT, duration at least 12 weeks full-time or over a correspondingly longer period part-time

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Elective Area (Elective: 1 item)** | | | | |
| **M-CIWVT-107422** | Internship | **DE** | **WT+ST** | **12 CP** |
| **M-CIWVT-107423** | Research Internship | **DE** | **WT+ST** | **12 CP** |

## 4.15 Interdisciplinary Qualifications valid SoSe 26

**Credits**
4

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Scientific Writing and Presenting (Elective: at least 2 credits)** | | | | |
| **M-CIWVT-106526** | Journal Club - Novel Bioproduction Systems | **DE/EN** | **WT** | **2 CP** |
| **M-CIWVT-107667** | Advanced Scientific Methods | **EN** | **ST** | **2 CP** |

## 4.16 Additional Achievements

| ID | Name | Language | Term offered | Credits |
|---|---|---|---|---|
| **Additional Examinations (Elective: at most 30 credits)** | | | | |
| **M-FORUM-106753** | Supplementary Studies on Science, Technology and Society | **DE** | **WT+ST** | **16 CP** |

# 5 Modules

## M 5.1 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-110902** | Additive Manufacturing for Process Engineering - Examination | **ST** | **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 lastin approx. 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 5.2 Module: Advanced Scientific Methods [M-CIWVT-107667]

**Coordinators:** Prof. Dr.-Ing. Alexander Grünberger
**Organisation:** KIT Department of Chemical and Process Engineering
**Part of:** Interdisciplinary Qualifications valid SoSe 26

| Credits | Grading | Recurrence | Duration | Language | Level | Version |
|---|---|---|---|---|---|---|
| 2 CP | pass/fail | Each summer term | 1 term | English | 4 | 1 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-115020** | Advanced Scientific Methods | **ST** | **2 CP** | **Grünberger** |

**Assessment**
Learning control is an completed coursework (ungraded).
Attendance requirements: Students have to attend at least 7/10 individual courses.

**Prerequisites**
None.

**Competence Goal**
Subject-Specific and Methodological Competencies:

- Ability to design, conduct, and critically evaluate scientific research using appropriate methods
- Competence in analyzing scientific literature and applying principles of good scientific practice
- Skilled use of AI tools to support research and academic writing

Social and Self-Competence:

- Active participation in discussions and collaborative work
- Development of critical thinking and reflective learning skills
- Responsible and ethical approach to research and use of AI tools

**Content**
**Introduction**

The course Advanced Scientific Methods equips Master's students with the essential **skills required** to conduct, evaluate, and communicate **high-quality research** in an increasingly data-driven and interdisciplinary environment. Building on foundational knowledge, the course deepens students' understanding of both qualitative and quantitative research methodologies, enabling them to design robust studies and critically assess scientific evidence.

A central focus lies on developing the ability to engage with scientific literature in a structured and reflective manner. Students will learn how to identify research gaps, evaluate methodological rigor, and synthesize findings across disciplines. In parallel, the course strengthens academic writing skills, guiding students in producing clear, coherent texts that adhere to established standards of good scientific practice.

Ethical considerations, including transparency, reproducibility, and responsible data handling, are integrated throughout the course. In addition, students will explore the growing role of artificial intelligence in research processes. They will learn how to effectively and responsibly use AI tools to support literature review, data analysis, and writing, while critically reflecting on their limitations and implications.

Overall, the course prepares students to navigate and contribute to modern scientific practice with confidence, integrity, and methodological rigor.

**Course objectives**

This course aims to equip students with advanced scientific methods for designing, conducting, and evaluating research. Students will develop critical reading and academic writing skills, apply principles of good scientific practice, and use AI tools responsibly. The objective is to foster methodological rigor, ethical awareness, and independent research competence across disciplines.

**Course structure**

The course is structured as **interactive lectures combined with integrated exercises**. Short theoretical inputs are complemented by practical tasks, discussions, and collaborative activities. Students are encouraged to actively participate, reflect on concepts, and apply methods directly. The course material is delivered in a mixture of lectures and practical exercises.

**Module Grade Calculation**
Non-graded.

**Workload**
Attendance time: 10 lecture sessions = 20 hrs

Preparatione an wrap-up = 40 hrs

**Literature**
All lecture slides will be provided within the “KIT-ILIAS” platform.

# M 5.3 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113429** | Alternative Protein Technologies | **ST** | **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 5.4 Module: B2B Sales Management [M-WIWI-107904]

**Coordinators:** Prof. Dr. Martin Klarmann
**Organisation:** KIT Department of Business and Economics
**Part of:** Specialization: Design of Food Products

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

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-WIWI-111367** | B2B Sales Management | **WT** | **4 CP** | **Klarmann** |

**Assessment**
The assessment of success takes place through the preparation and presentation of a sales presentation based on a case study (max 30 points) and a written exam with additional aids in the sense of an open book exam (max. 60 points). In total, a maximum of 90 points can be achieved in the course. Further details will be announced during the lecture.

**Prerequisites**
None

**Competence Goal**
Students

- Are familiar with marketing and sales peculiarities and challenges in B2B environments
- Are able to identify different B2B business types and their marketing characteristics
- Are familiar with central theories of organizational buying behavior
- Are familiar with central objectives of Customer Relationship Management in B2B environments and are able to implement them with appropriate tools
- Are able to prioritize customers and calculate B2B Customer Lifetime Value
- Know how B2B sales presentations work and have also gained practical experience in this area
- Are able to determine value-based prices

**Content**
The event is designed to teach you taking on marketing responsibility in a very special business environment. This involves companies that sell and market their (often technically highly complex) products themselves to other companies, which is referred to as "business-to-business" (B2B) marketing and sales. Since traditional communication instruments (e.g. advertising) often hardly work in this environment and many projects lead to a long-term cooperation between supplier and customer, (personal) sales play a special role in marketing. Therefore, this event introduces marketing in B2B markets on the one hand and deals with questions of sales and distribution on the other hand.

Topics with regard to B2B sales management are:

- Basic aspects of B2B sales and B2B purchasing
- Understanding of marketing challenges in specific B2B business types (commodities, systems, solutions)
- Value pricing and value-based selling
- Organizational buying behavior
- Basics of B2B customer relationship management (e.g. key account management, reference customer management)
- Sales process (lead generation, sales presentations, customer-oriented selling, closing)
- Sales automation

**Additional Information**
For further information, please contact Marketing and Sales Research Group (marketing.iism.kit.edu).

**Workload**
The total workload for this course is approximately 120 hours.
Attendance time: 35.0 hours
Self-study: 85 hours

# M 5.5 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 | 2 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-ETIT-113986** | Batteries, Fuel Cells, and Electrolysis | **WT** | **5 CP** | **Krewer** |
| **T-ETIT-114957** | Batteries, Fuel Cells, and Electrolysis - Group Project<br>***This item will not influence the grade calculation of this parent.*** | **WT** | **1 CP** | **Krewer** |

**Assessment**
Success control takes place in the form of:

1. an ungraded written technical report (approx. 7-10 pages).
2. a graded 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 5.6 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-109369** | Biobased Plastics | **WT** | **4 CP** | **Kindervater** |

**Assessment**
Learning control is a written exam lasting 60 minutes.

**Prerequisites**
None

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

**Workload**

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

# M 5.7 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106841** | Biofilm Systems | **ST** | **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 5.8 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108828** | Energy from Biomass | **WT** | **6 CP** | **Bajohr** |

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

**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 hrs
- Homework: 75 hrs
- Exam Preparation: 60 hrs

**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 5.9 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MACH-100966** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I | **WT** | **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 5.10 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MACH-100967** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II | **ST** | **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 5.11 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MACH-100968** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III | **ST** | **4 CP** | **Guber** |

**Assessment**
Written exam (75 min)

**Prerequisites**
none

**Competence Goal**

- Students are able to describe relevant microtechnical production methods, explain their functional principle and evaluate their use for biomedical and biotechnological applications as well as for BioMEMS.
- Students are able to analyze the use of microstructures and microsystems in life sciences and (bio)medicine using specific examples and assess their influence on medical technology and biotechnology products and systems.
- Students can explain examples of applications in the life sciences and biotechnology, such as microfluidic systems (e.g. lab-on-a-chip, digital microfluidics), biochips, tissue engineering, organ-on-a-chip, drug delivery systems, respiratory gas analysis and neuroprosthetics (e.g. artificial retina, exoskeletons) and compare their technical requirements.
- Students can explain examples of applications in minimally invasive surgery, neurosurgery, interventional cardiology and vascular therapy as well as NOTES and surgical robotics and compare their technical requirements.
- Students will be able to describe and apply the key requirements of the Medical Devices Act and the principles of quality management for medical technology products.

**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 5.12 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 | 2 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MACH-106877** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV | **WT** | **4 CP** | **Ahrens, Guber** |

**Assessment**
Oral exam (approx. 45 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.

**Module Grade Calculation**
Module grade corresponds to the grade of the partial performance.

**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 5.13 Module: Biopharmaceutical Purification Processes [M-CIWVT-107629]

**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114959** | Biopharmaceutical Purification Processes | | **6 CP** | **Hubbuch** |

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

**Prerequisites**
None

**Competence Goal**
The students can

- evaluate and design process steps
- evaluate and design processes,
- explain the relationships between process parameters, product yield and purity.

**Content**
**Module objective:**
The module teaches the basic principles, methods and challenges of processing biopharmaceutical active ingredients. Students acquire knowledge of the processing of biopharmaceutical active ingredients, central reaction and purification processes and their application in industrial biopharmaceutical production.

**Contents:**

- Overview of biopharmaceutical products and process chains
- Biological mode of action of the pharmaceuticals presented
- Central purification processes
- Reactive processes
- Special features in the processing of biopharmaceutical products
- Processing of peptides, hormones, antibodies, vaccines, viruses, cell and gene therapy, etc.

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

**Workload**

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

**Literature**
Vorlesungsskript

# M 5.14 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113712** | Bioprocess Scale-up | **WT** | **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: 60 hrs
- Homework: 80 hrs
- Exam preparation: 40 hrs

**Recommendations**
Fundamentals of Bioprocess Engineering.

**Literature**
No specific textbook is recommended.

# M 5.15 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113315** | Bioreactor Development | | **4 CP** | **Holtmann** |

# M 5.16 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113714** | Biosensors | **WT+ST** | **4 CP** | **Kabay** |

# M 5.17 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113237** | Biotechnological Use of Renewable Resources | **WT** | **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 5.18 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113677** | C1-Biotechnology Exam | | **4 CP** | **Neumann** |
| **T-CIWVT-113678** | C1-Biotechnology Presentation | | **2 CP** | **Neumann** |

**Assessment**
The learning control consits of two componets:

- oral exam lasting approx. 30 minutes
- ungrade coursework: Seminar presentation

**Prerequisites**
Prerequisite for participation in the module: None.
Prerequisite within the module: Participation in the oral examination is only possible after attending the seminar/passing the presentation.

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

**Workload**

- Attendance time: 45 hrs
- Homework:
  - Preparation of seminar presentation: 40 hrs
  - Preparation and wrap-up of the lecture: 55 hrs
- Exam preparation: 40 hrs

# M 5.19 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108811** | Commercial Biotechnology | **ST** | **4 CP** | **Kindervater** |

**Assessment**
Learning control is a written exam lasting 60 minutes.

**Prerequisites**
None

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

**Workload**

- Lectures: 30 h
- Homework: 50 h
- Exam Preparation: 40 h (about one week)

# M 5.20 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106035** | Computational Fluid Dynamics | **WT+ST** | **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 5.21 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 | 3 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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.

**Teaching and Learning Methods**
Lecture + project-oriented Practical Course (2 +2 weekly contact hours)

# M 5.22 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.23 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.24 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-INFO-114219** | Deep Learning and Neural Networks | **ST** | **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**
Lecture with 4 SWS, 6 CP.
6 LP corresponds to approx. 180 hours, of which
approx. 60 hours lecture attendance
approx. 90 hours post-processing (self-study)
approx. 30 hours exam preparation (self-study)

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

# M 5.25 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108960** | Development of an Innovative Food Product | **WT+ST** | **3 CP** | **van der Schaaf** |
| **T-CIWVT-111010** | Development of an Innovative Food Product - Presentation | **WT+ST** | **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**
The module lasts two semesters and usually starts in the summer semester.

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 5.26 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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
2. Oral exam lasting approx. 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 hrs
- Homework (CAD-design): 80 hrs
- Exam preparation: 40 hrs

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

# M 5.27 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-110111** | Digitization in Particle Technology | **WT** | **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 5.28 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114105** | Dynamics Process Engineering Systems - Prerequisite | **ST** | **3 CP** | **Jerono** |
| **T-CIWVT-114106** | Dynamics of Process Engineering Systems - Exam | **ST** | **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 5.29 Module: Electrification of the Process Industry [M-CIWVT-107653]

**Coordinators:** Prof. Dr.-Ing. Frederik Scheiff
**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-115000** | Electrification of Process Industry | | **4 CP** | **Scheiff** |

**Assessment**
Learning control is an oral exam lasting approx. 25 minutes.

**Prerequisites**
None.

**Competence Goal**
Students are able to

- distinguish different methods of electrical energy supply to process-industry applications
- based on chemical and electrical fundamentals,
- to perform basic engineering calculations, and
- to critically assess these methods with respect to process-, electrical-, and materials-engineering criteria.

Students are capable of:

- evaluating current developments in the field of electrification,
- reflecting on application areas and their contribution to sustainability,
- performing basic techno-economic assessments, and
- adressing interdisciplinary interfaces between process engineering, electrical engineering, and materials science.

**Content**
Process Industry and its connection to the Energy System

- impact of process industry and its energy consumption
- German energy system (infrastructure, energy market, regulatory framework)

Electrical Engineering and Physical Fundamentals

- Basic concepts of electrical engineering (current, voltage, etc.)
- Electromagnetism, electrical energy converters, materials used in electrical engineering

Electrification of Thermal Energy Demands

- Direct electric heating (ohmic heating, inductive heating, plasma, microwaves)
- Indirect methods (heat pumps, power-to-steam, special processes, technology comparison of combustion vs. (in)direct electrification)

Electrification of Chemical Enthalpy Demands

- Electrolysis, electrified organic syntheses, electrocatalysis

Electrification of Mechanical Drives

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

**Workload**

- Attendance time: 30 hrs
- Homework: 60 hrs
- Exam preparation: 30 hrs

# M 5.30 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 summer term | 1 term | German | 5 | 2 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113148** | Electrobiotechnology | | **4 CP** | **Holtmann** |
| **T-CIWVT-113829** | Electrobiotechnology Seminar | | **2 CP** | **Holtmann** |

# M 5.31 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 |
|---|---|---|---|---|---|---|
| 6 CP | graded | Each summer term | 1 term | English | 4 | 4 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-ETIT-111831** | Electrocatalysis | **ST** | **6 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 5.32 Module: Electrochemistry [M-CHEMBIO-106697]

**Coordinators:** Prof. Dr. Dominic Bresser
**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CHEMBIO-109773** | Electrochemistry | **Irreg.** | **3 CP** | |

**Prerequisites**
None

# M 5.33 Module: Emulsification Technology [M-CIWVT-107439]

**Coordinators:** Dr.-Ing. Ulrike van der Schaaf
**Organisation:** KIT Department of Chemical and Process Engineering
**Part of:** Process Engineering
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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114611** | Emulsification Technology | **ST** | **4 CP** | **van der Schaaf** |

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

**Prerequisites**
None

**Competence Goal**
At the end of the course, students possess an advanced, scientifically sound understanding of the physicochemical and process engineering fundamentals of emulsion formation and stabilization. They are able to analyze droplet break-up and stabilization phenomena in liquid systems and to implement and design corresponding processing equipment. Students can purposefully select and evaluate emulsifiers and stabilizers with respect to their molecular structure and functionality, assess the relevance of interfacial tension and interfacial elasticity for emulsion stability, and choose appropriate methods for the characterization and evaluation of product quality. Furthermore, they are capable of critically assessing current developments in emulsion technology and transferring this knowledge to complex engineering problems.

**Content**
Fundamentals of droplet break-up and stabilization in liquid environments; equipment-oriented implementation: plant configuration and process design; process–property relationships; emulsifiers and stabilizers: molecular structure and characteristics; relevance and characterization of interfacial tension and interfacial elasticity for emulsion stabilization; assessment of product quality: fundamentals and measurement methods; recent developments.

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

**Workload**

- Attendance time: 30 hrs
- Homework: 60 hrs
- Exam preparation: 30 hrs

**Literature**


- Köhler, K., Schuchmann, H. P.: Emulgiertechnik, 3. Auflage, Behr's Verlag, Hamburg, 978-3-89947-869-3, 2012
- McClements, D.J.; Food Emulsions – Principles, Practices and Techniques, 3. Auflage, CRC Press, 978-1498726689, 2015

# M 5.34 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MACH-114731** | Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics | **WT** | **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 5.35 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-112174** | Extrusion Technology in Food Processing | **WT** | **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. 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 5.36 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CHEMBIO-109442** | Food Chemistry Basics | **ST** | **4 CP** | **Bunzel** |

**Prerequisites**
None

**Workload**

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

# M 5.37 Module: Food Processing in Practice [M-CIWVT-107679]

**Coordinators:** Dr.-Ing. Ulrike van der Schaaf
**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-109129** | Seminar of Food Processing in Practice with Excursion | **WT** | **2 CP** | **van der Schaaf** |

**Assessment**
Learning control is an oral exam lasting approx. 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**
As part of an excursion, students visit selected food processing companies of different sizes - from start-ups to internationally active companies. The companies represent different product groups and processing methods.

This gives students the opportunity to understand process steps learned in other courses in industrial practice in a large-scale context and to analyze differences and special features of food processing depending on company size and production structure.

The seminar is used to prepare for and follow up on the excursion, for in-depth analysis of the manufacturing processes observed and to discuss current industrial issues.

**Workload**

- Attendance time: Seminar and excursion 30 h
- Homework: 15 h
- Exam preparation: 15 h

# M 5.38 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108805** | Formulation of (Bio)pharmaceutical Therapeutics | **WT** | **4 CP** | **Hubbuch** |

**Assessment**
Learning control is an oral exam lasting approx. 15 minutes.

**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 hrs
- Homework: 60 hrs
- Exam preparation: 30 hrs

# M 5.39 Module: Fundamentals of Water Quality [M-CIWVT-103438]

**Coordinators:** Prof. Dr.-Ing. Marta Markiewicz
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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106838** | Fundamentals of Water Quality | **WT** | **6 CP** | **Markiewicz, 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), 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 5.40 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108937** | Heat Exchangers | **WT** | **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 5.41 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108836** | Hydrogen and Fuel Cell Technologies | **ST** | **4 CP** | **Trimis** |

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

**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 hrs
- Homework: 60 hrs
- Exam Preparation: 30 hrs

**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 5.42 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-110935** | Industrial Aspects in Bioprocess Technology | **ST** | **4 CP** | **Hubbuch** |

**Assessment**
Learning control ist an oral exam lasting approx. 15 minutes.

**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 5.43 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113432** | Industrial Biocatalysis | **ST** | **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 5.44 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113120** | Industrial Bioprocesses | **WT** | **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 5.45 Module: Industrial Wastewater Treatment [M-CIWVT-105903]

**Coordinators:** Prof. Dr.-Ing. Marta Markiewicz
**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-111861** | Industrial Wastewater Treatment | **ST** | **4 CP** | **Markiewicz** |

**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 5.46 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108980** | Innovation Management for Products and Processes in the Chemical Industry | **WT** | **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 5.47 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114573** | Internship | **WT+ST** | **12 CP** | **Bajohr, Freudig** |

**Workload**
12 weeks, at least 360 hrs.

# M 5.48 Module: Introduction to Artificial Intelligence [M-INFO-106014]

**Coordinators:** Prof. Dr. Pascal Friederich
Prof. Dr. Gerhard Neumann
**Organisation:** KIT Department of Informatics
**Part of:** Computer-aided Methods

| Credits | Grading | Recurrence | Duration | Language | Level | Version |
|---|---|---|---|---|---|---|
| 6 CP | graded | Each winter term | 1 term | German | 3 | 2 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-INFO-112194** | Introduction to Artificial Intelligence | **WT** | **6 CP** | **Friederich, Neumann** |

# M 5.49 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.50 Module: Introduction to Sensory Analysis [M-CIWVT-105933]

**Coordinators:** Prof. Dr. Mirko Bunzel
**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-109128** | Introduction to Sensory Analysis with Practice | **ST** | **2 CP** | **Bunzel** |

# M 5.51 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 valid SoSe 26

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

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113149** | Journal Club - Novel Bioproduction Systems | **WT** | **2 CP** | **Holtmann** |

# M 5.52 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 | 2 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106032** | Kinetics and Catalysis | **ST** | **6 CP** | **Wehinger** |

**Assessment**
Learning control is a written examination lasting 90 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): 45 h
- Homework: 90 h
- Exam Preparation: 45 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 5.53 Module: Managing the Marketing Mix [M-WIWI-107905]

**Coordinators:** Prof. Dr. Martin Klarmann
**Organisation:** KIT Department of Business and Economics
**Part of:** Specialization: Design of Food Products (Usage from 4/1/2027)

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

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-WIWI-102805** | Managing the Marketing Mix | **ST** | **4 CP** | **Klarmann** |

**Assessment**
The assessment of success takes place through the preparation and presentation of a case study (max. 30 points) as well as a written exam with additional aids in the sense of an open book exam (max. 60 points). In total, a maximum of 90 points can be achieved in the course. Further details will be announced during the lecture.

**Prerequisites**
None

**Competence Goal**
Students

- know the meaning of the branding, the brand positioning and the possibilities of the brand value calculation
- understand the price behavior of customers and can apply this knowledge to the practice
  know different methods for price determination (conjoint analysis, cost-plus determination, target costing, customer surveys, bidding procedures) and price differentiation
- are able to name and explain the relevant communication theories
- can identify crisis situations and formulate appropriate response strategies
- can name and judge different possibilities of the Intermediaplanung
- know various design elements of advertising communication
- understand the measurement of advertising impact and can apply it
- know the basics of sales organization
- are able to evaluate basic sales channel decisions

**Content**
The content of this course concentrates on the elements of the marketing mix. Therefore the main chapters are brand management, pricing, promotion and sales management.

For further information please contact Marketing & Sales Research Group (marketing.iism.kit.edu).

**Workload**

- Total workload for 4 credit points: approx. 120 hours
- Attendance: 30 hours
- Private study: 90 hours

# M 5.54 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114397** | Master's Thesis | **WT+ST** | **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 5.55 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108146** | Materials and Processes for Electrochemical Storage | **WT+ST** | **4 CP** | **Tübke** |

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

**Prerequisites**
None

**Competence Goal**
The students will be able to

- explain how electrochemical storage devices and converters (expecially batteries and fuel cells) work and describe typical electrochemical processes using the relevant fundamentals,
- evaluate active and passive materials used in terms of their chemical, physical, and electrochemical properties,
- select suitable manufacturing or modification processes for defined requirements,
- compare process engineering methods for manufacturing battery cells and assess their influence on performance, safety, and sustainability.

**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, 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.

**Production methods and processes for manufacturing battery cells**
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, Quality assurance processes in cell production, cell forming and testing processes for 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 5.56 Module: Membrane Technologies in Water Treatment [M-CIWVT-105380]

**Coordinators:** 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113235** | Exercises: Membrane Technologies | **ST** | **1 CP** | **Saravia** |
| **T-CIWVT-113236** | Membrane Technologies in Water Treatment | **ST** | **5 CP** | **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**
Will be announced in the lecture.

# M 5.57 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108909** | Microfluidics | **WT** | **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 5.58 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-110549** | Microfluidics - Case Studies | **WT** | **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 5.59 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114600** | Microsystems in Bioprocess Engineering | | **4 CP** | **Grünberger** |

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

**Competence Goal**
Subject-Specific and Methodological Competencies:

- Understand the fundamental principles and current applications of microsystems in bioprocess engineering
- Identify and describe characteristic features and functionalities of selected microsystem
- Analyze and compare different microsystem approaches
- Critically assess technological advancements, opportunities, and challenges in the field of micro-bioprocess engineering
- Develop the ability to design, operate, and interpret experiments using miniaturized and microfluidic systems relevant to bioprocess development

Social and Self-Competence:

- Communicate effectively about complex bioprocess engineering topics, addressing both expert and non-expert audiences.
- Engage in independent learning and critical reflection to continuously expand knowledge and skills in the rapidly evolving field of microsystems in bioprocess engineering.
- Develop and evaluate (interdisciplinary) courses of action for bioprocess engineering challenges, considering multiple perspectives and potential impacts.
- Acquire the ability to independently familiarize oneself with new and complex topics, demonstrating self-initiative and adaptability.

**Content**

## Introduction

Traditional bioprocesses have long relied on large-scale systems, which, while effective, often limit flexibility, throughput, and detailed analysis. Bioprocess engineering is experiencing a paradigm shift thanks to the ongoing miniaturization of bioreactor concepts, downstream processing, and analytical methods. This technological progress forms the foundation of the emerging field of Micro-bioprocess engineering. Miniaturized bioreactors, for example, have been developed to significantly increase throughput in screening studies, enabling rapid and parallel experimentation. The latest advancements even extend to sophisticated microfluidic systems, such as droplet and single-cell bioreactors, which allow for unprecedented precision and control. The portfolio of microsystems in bioprocess engineering has recently expanded to include not only small-scale bioreactors but also miniaturized downstream processes and advanced analytical tools. These microsystems are now being increasingly integrated into bioprocess development, driving innovation across biotechnology, biology, and medicine. Latest developments include the use of microsystems as biomanufacturing systems.

## Course objective

The objective of this course is to provide students with a comprehensive introduction to the field of microsystems in bioprocess engineering. Students will gain an understanding of current application areas and become familiar with selected micro-bioprocess engineering systems, with a particular focus on miniaturized bioreactor concepts. Through the discussion of characteristic features and functionalities, illustrated by current scientific examples, students will explore the diverse possibilities for applying these technologies in biotechnology and microbiology. The course emphasizes the significance of microsystems in modern bioprocess development and highlights their interdisciplinary nature, fostering collaboration across molecular biotechnology, microbiology, biochemistry, chemical engineering, and related life sciences. By the end of the lecture, students will be able to critically assess future concepts, opportunities, and challenges in micro-bioprocess engineering and understand its growing impact on biotechnology and adjacent fields. This application-oriented course is designed for technically interested students from a variety of scientific backgrounds.

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

**Workload**

- Attendance time: 30 hrs
- homework: 60 hrs
- exam preparation: 30 hrs

# M 5.60 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-110895** | Mixing, Stirring, Agglomeration | **ST** | **6 CP** | **Rhein** |

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

**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 hrs
Homework: 75 hrs
Exam preparation: 60 hrs

# M 5.61 Module: Modeling Physiological Systems [M-ETIT-106782]

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

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

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-ETIT-113630** | Modeling Physiological Systems | **ST** | **6 CP** | **Loewe** |
| **T-ETIT-114690** | Modeling Physiological Systems - Workshop | **ST** | **0 CP** | **Loewe** |

**Assessment**

- The examination takes place in form of a written examination lasting 90 min.
- The submission of the ungraded workshop (2 exercise sheets) 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 disease entity 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: 42h

Programming exercises25h+25h = 50h

A total of 180 h = 6 CR

**Recommendations**
Basic knowledge of

- ordinary differential equations and linear algebra (e.g. Höhere Marthematik I, Höhere Mathematik III),
- system dynamics and control engineering (e.g. Signale und Systeme)
- programming in a scripting language like Python or Matlab (e.g. Informationstechnik I)
- version control using git and GitLab (e.g. Practical Introduction to Research Software Engineering)
- human anatomy & physiology (e.g. Physiologie und Anatomie für die Medizintechnik)

# M 5.62 Module: Molecular Biology and Genetics [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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.63 Module: Multimodal Artificial Intelligence [M-INFO-107676]

**Coordinators:** Prof. Dr. Jan Niehues
Prof. Dr.-Ing. Rainer Stiefelhagen
**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 | 2 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-INFO-115041** | Multimodal Artificial Intelligence | **ST** | **6 CP** | **Niehues, Stiefelhagen** |

**Assessment**
See Partial Achievements (Teilleistung).

**Prerequisites**
See Partial Achievements (Teilleistung).

**Competence Goal**

- The students know the relevant elements of a multimodal AI .
- The students understand the algorithms and methods of multimodal AI.
- 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, multimodal AI systems are increasingly integrated into our everyday lives. These are, for example, systems that can understand and generate language and speech or analyze images and videos. Furthermore, advanced video and image generation AI shows leads to new applications

Based on the knowledge of the lecture “Introduction to AI”, the students learn to understand, develop and evaluate multimodal AI Systems.
In order to bring this knowledge closer to the students, the lecture is divided into 5 parts. First, the lecture investigates method of speech and language perception followed by a part about visual perception. The second part deals speech and language generation followed by a part about video processing. Finally, multimodal AI methods 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 (self-study)
approx. 30 hours exam preparation (self-study)

**Recommendations**
See Partial Achievements (Teilleistung).

# M 5.64 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108984** | NMR for Engineers | **WT** | **4 CP** | **Guthausen** |
| **T-CIWVT-109144** | Laboratory Work for NMR for Engineers | **WT** | **2 CP** | **Guthausen** |

**Prerequisites**
None

**Competence Goal**
Students will be able to

- explain the physical principles of nuclear magnetic resonance (NMR) and describe the underlying phenomena.
- identify various areas of application for NMR and assess its usefulness in the fields of bioengineering/chemical engineering & process engineering.
- understand and critically evaluate the functioning and usefulness of the NMR method using concrete examples.

**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 5.65 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-111843** | NMR Methods for Product and Process Analysis | **WT** | **4 CP** | **Guthausen** |

**Prerequisites**
None

**Competence Goal**
Students will be able to

- explain the physical principles of nuclear magnetic resonance (NMR) and describe the underlying phenomena.
- identify various areas of application for NMR and assess its usefulness in the fields of bioengineering/chemical engineering & process engineering.
- understand and critically evaluate the functioning and usefulness of the NMR method using concrete examples.

**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.

**Additional Information**
If required, the module can be offered in English.

**Workload**

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

**Literature**
Textbooks: Kimmich and Callaghan; further reading will be announced during the lectures.

# M 5.66 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 | English | 5 | 1 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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.

**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 5.67 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 | English | 5 | 1 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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.

**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 5.68 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.69 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MACH-105228** | Organ Support Systems | **ST** | **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 5.70 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 | Language | Level | Version |
|---|---|---|---|---|---|---|
| 6 CP | graded | Irregular | 1 term | German/English | 5 | 3 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MATH-102271** | Parallel Computing | **Irreg.** | **6 CP** | **Krause, Wieners** |

**Assessment**
Examination prerequisite: passed computer lab

Success is assessed in the form of an oral examination lasting approx. 20 minutes.

**Prerequisites**
None

**Competence Goal**
Graduates

- know the fundamentals of parallel computing,
- have an overview of scientific computing concepts on parallel computers,
- have theoretical and practical experience with parallel programming models and parallel solution methods,
- can independently implement simple practical tasks in a scalable manner

**Content**

- Parallel programming models
- Parallel solving of linear equation systems
- Parallel finite differences, finite elements, finite volumes methods
- Domain decomposition methods
- Parallel matrix-matrix and matrix-vector operations
- Convergence and performance analysis
- Load balance techniques
- Applications from the natural sciences and engineering

**Module Grade Calculation**
The module grade is the grade for the oral examination.

**Workload**
Total workload: 180 hours

Attendance time: 60 hours

- Course including module examination

Self-study: 120 hours

- Consolidation of course content through follow-up work on lecture content at home
- Completion of exercises
- Consolidation of course content using appropriate literature and internet research
- Preparation for the module examination

**Recommendations**
Knowledge of a higher-level programming language (C++, Java, Fortran) and basic knowledge of the numerical treatment of differential equations (finite differences or finite elements) are recommended.

**Teaching and Learning Methods**
Lecture + computer-based tutorial in the lab (2+2 weekly contact hours)

# M 5.71 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106028** | Particle Technology Exam | | **6 CP** | **Dittler** |

**Assessment**
Learning control is a written examination lasting 135 minutes (15 minutes reading time and 120 minutes to complete the tasks).

**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 5.72 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114537** | Plant an System Design | **WT+ST** | **6 CP** | **Grünberger, Holtmann** |

# M 5.73 Module: Practical Course in Water Technology [M-CIWVT-103440]

**Coordinators:** Dr. Andrea Hille-Reichel
**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106840** | Practical Course in Water Technology | **WT** | **3 CP** | **Hille-Reichel** |
| **T-CIWVT-110866** | Excursions: Water Supply | **WT** | **1 CP** | **Hille-Reichel** |

**Assessment**
The learning control consists of:

- Laboratory: 6 Experiments including entrance test, protocol; presentation about a selected experiment (about 15 minutes); final test
- Two 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**
Introductory lecture and student presentations in three 90-minute sessions.
Lab: Six experiments on the topics of

- equilibrium study of the calcium carbonate system
- flocculation
- adsorption on activated carbon
- photochemical oxidation
- liquid chromatography
- sum parameters

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 5.74 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.75 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-MACH-105235** | Principles of Medicine for Engineers | **WT** | **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 5.76 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-ETIT-114417** | Printed and Thin-Film Electronics | **WT** | **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 5.77 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-ETIT-111214** | Process Analysis: Modeling, Data Mining, Machine Learning | **ST** | **3 CP** | **Borchert, Heizmann** |

**Assessment**
Success control takes place in the form of an oral examination lasting approx. 30 minutes.

**Prerequisites**
none

**Competence Goal**
Students learn about process engineering issues from the perspective of industrial practice, which are dealt with using physico-chemical modeling and data science methods. Students learn about important relationships in process engineering and can explain these using example processes. They are able to recognize relevant process data and select and apply suitable modelling approaches for their interpretation. Students can carry out practical analyses with process data and apply methods of varying complexity. Students are familiar with the data analysis value chain and are able to select a suitable data analysis method. The focus is on teaching broad methodological knowledge and application using practical examples. Students are referred to specialized in-depth lectures and/or in-depth literature.

**Content**
**Aims of process technology**

- Material and energy conversion by means of chemical, mechanical, thermal or biological operations
- Basic operations (selection)
- System examples
- Important variables in process technology (temperature, pressure, composition,...)
- Economic efficiency in the process industry

**Data acquisition**

- Measured variables and measuring principles (selection)
- Measurement uncertainty

**Models of process technology**

- Balance equations (selection)
- Constitutive equations (selection)
- Solving balance equations (example in Matlab)
- Parameter uncertainty and estimation
- Data-driven models
- Grey box models / hybrid models

**Data analysis**

- Requirements for data analysis in the process industry
- Cost-effectiveness and prioritization of process analyses
- Data pre-treatment
- Application of data mining and machine learning
- Online processes

**Excursion**

- Excursion to BASF Ludwigshafen

**Term paper 1:** Process model and simulation.

**Term paper 2:** Identification and analysis.

**Homework 3:** Predictive maintenance.

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

**Workload**
28 hours of teaching,

30 hrs. Homework,

32 hours of preparation and follow-up work, exam preparation and implementation.

**Recommendations**
Basics in: Mathematics, differential equations, linear algebra, statistics, basic knowledge of Matlab

**Literature**
Bequette (1998). Process Dynamics: Modeling, Analysis and Simulation. Prentice Hall.

Russel & Novig (2016). Artificial Intelligence - A modern approach. Pearson.

Matlab Documentation (In2019). Mathworks.

# M 5.78 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114498** | Process and Plant Design in Biotechnology - Seminar | **ST** | **2 CP** | **Holtmann** |
| **T-CIWVT-114499** | Process and Plant Design in Biotechnology - Written Exam | **WT** | **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 5.79 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108912** | Process and Plant Safety | **ST** | **4 CP** | **Schmidt** |

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

**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.

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

**Workload**

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

# M 5.80 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113477** | Process Engineering for the Production of Food from Animal Origins | **ST** | **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 5.81 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113476** | Process Engineering for the Production of Food from Plant-Based Raw Materials | **WT** | **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

**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

# M 5.82 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108910** | Process Instruments and Machinery and Their Process Integration | **WT** | **4 CP** | **Nagel** |

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

**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 hrs
- Homework: 60 hrs
- Exam Preparation: 30 hrs

# M 5.83 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106101** | Process Modeling in Downstream Processing | **WT** | **4 CP** | **Franzreb** |

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

**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)

**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 5.84 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108997** | Processes and Process Chains for Renewable Resources | **ST** | **6 CP** | **Dahmen, Sauer** |

**Assessment**
Learning control is an oral examination lastin approx. 20 minutes.

**Prerequisites**
None

**Competence Goal**
The students become able to:

- understand and assess the technical background of important process steps for the utilization of renewable resources,
- Establish process chains for converting various renewable raw materials,
- apply the lessons learned to develop biorefinery concepts for manufacturing products (e.g., platform chemicals, materials) from renewable raw resources.
- Students will be able to apply the content taught in the lecture to the exemplary development of a biorefinery and present the results in a structured manner in the form of a seminar presentation.

**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.

**Workload**

- Lectures and exercises: 45 hrs
- Homework: 45 hrs
- Preparation of exercises: 30 hrs
- Prepration of presentations: 30rs
- Exam preparation: 30 h

# M 5.85 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106107** | Processing of Nanostructured Particles | **WT** | **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 5.86 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113230** | Production and Development of Cancer Therapeutics | **WT** | **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 5.87 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 |
|---|---|---|---|---|---|---|
| 6 CP | graded | Each summer term | 1 term | English | 4 | 2 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-113224** | Reactor Modeling with CFD | | **6 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: 90 h
- Exam preparation: 45 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 5.88 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108831** | Refinery Technology - Liquid Fuels | **ST** | **6 CP** | **Rauch** |

**Assessment**
Learning control is an oral examination lasting approx. 20 minutes.

**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 hrs
- Homework: 75 hrs
- Exam Preparation: 60 hrs

**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 5.89 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Research Internship (Elective: at most 12 credits)** | | | | |
| **T-CIWVT-114575** | Biopharmaceutical Process Engineering | **WT+ST** | **12 CP** | **Hubbuch** |
| **T-CIWVT-114613** | Data-Driven Methods in Bioengineering: Modeling and Autonomous Experimentation | **WT+ST** | **12 CP** | **Franzreb** |
| **T-CIWVT-114612** | Gas Fermentation | **WT+ST** | **12 CP** | **Dahmen** |
| **T-CIWVT-114574** | Intensification of Bio-Processes | **WT+ST** | **12 CP** | **Holtmann** |
| **T-CIWVT-114577** | Food Process Engineering | **WT+ST** | **12 CP** | **van der Schaaf** |
| **T-CIWVT-114576** | Multiscale Bioengineering | **WT+ST** | **12 CP** | **Grünberger** |
| **T-CIWVT-114614** | Water Technology | **WT+ST** | **12 CP** | **Markiewicz** |

**Workload**
360 h.

# M 5.90 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108884** | Rheology of Polymers | **ST** | **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

**Competence Goal**
Students are familiar with the essential characteristics and properties of polymer molecules and the molecular causes of macroscopic viscoelastic behavior.

Students are familiar with the most important models for describing the flow behavior of polymer melts, solutions, and gels. They can infer the molecular structure of the corresponding polymers from rheological data.

Students can evaluate the processing behavior of polymers based on rheological data.

**Content**
Fundamentals of (Shear) Rheometry & Rheological Phenomena, Linear Viscoelasticity, Polymers in Nature and Technology, What Is a Polymer? Chain Models and Statistics, Dilute and Moderately Concentrated Solutions, Rouse Model—From Molecule to Modulus!

Zimm Model—Intrinsic Viscosity, Molecular Weight, Molecular Architecture, Influence of Polymer Concentration and Solvent Quality, Concentrated Solutions and Melts, Entanglement Concept, Tube Models and Reptation, Influence of Molecular Weight Distribution and Glass Transition Temperature, Time-Temperature Superposition, Gels and Networks, Thickener Solutions.

Strain rheology and coating processes, technical significance—examples from industrial practice.

**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 5.91 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.92 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108897** | Solid Liquid Separation | **WT** | **8 CP** | **Gleiß** |

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

**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 hrs
- Homework: 80 hrs
- Exam Preparation: 100 hrs

**Literature**
Anlauf: Skriptum "Mechanische Separationstechnik - Fest/Flüssig-Trennung"

# M 5.93 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-108885** | Stability of Disperse Systems | **WT** | **4 CP** | **Willenbacher** |

**Assessment**
Learning control is an oral exam lasting approx. 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 hrs
• Homework: 70 hrs
• Exam Preparation: 20 hrs

# M 5.94 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!

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-FORUM-113578** | Lecture Series Supplementary Studies on Science, Technology and Society - Self Registration | **ST** | **2 CP** | **Mielke, Myglas** |
| **T-FORUM-113579** | Basic Seminar Supplementary Studies on Science, Technology and Society - Self Registration | **ST** | **2 CP** | **Mielke, Myglas** |
| **Advanced Unit Supplementary Studies on Science, Technology and Society (Elective: at least 12 credits)** | | | | |
| **T-FORUM-113580** | Elective Specialization Supplementary Studies on Science, Technology and Society / About Knowledge and Science - Self-Registration | **WT+ST** | **3 CP** | **Mielke, Myglas** |
| **T-FORUM-113581** | Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Society - Self-Registration | **WT+ST** | **3 CP** | **Mielke, Myglas** |
| **T-FORUM-113582** | Elective Specialization Supplementary Studies on Science, Technology and Society / Science in Public Debates - Self Registration | **WT+ST** | **3 CP** | **Mielke, Myglas** |
| **Mandatory** | | | | |
| **T-FORUM-113587** | Registration for Certificate Issuance - Supplementary Studies on Science, Technology and Society | **WT+ST** | **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 5.95 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **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 5.96 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114108** | Thermal Process Engineering III | **WT** | **6 CP** | **Zeiner** |

**Assessment**
Learning control is an examination of another type: The students independently carry out a simulation project of a thermal separation process in a commercial process simulator.

**Prerequisites**
The contents of the module Thermal Process Engineering II are a prerequisite.

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

**Workload**

- Attendance time: 60 hrs
- Homework: 60 hrs
- Exam preparation: 60 hrs

**Recommendations**
Thermodynamics III

# M 5.97 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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-114497** | Thermodynamics for Bioengineering | **ST** | **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 5.98 Module: Water Technology [M-CIWVT-103407]

**Coordinators:** Prof. Dr. Harald Horn
Prof. Dr.-Ing. Marta Markiewicz
**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 |

| ID | Name | Term offered | Credits | Lecturers |
|---|---|---|---|---|
| **Mandatory** | | | | |
| **T-CIWVT-106802** | Water Technology | **WT** | **6 CP** | **Horn, Markiewicz** |

**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

# 6 Module components

## T 6.1 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 2026** | **2241020** | Additive Manufacturing for Process Engineering | **2 SWS** | **Lecture /** 🗣 | **Klahn** |
| **WT 26/27** | **2241020** | Additive Manufacturing for Process Engineering - Announcement | **0 SWS** | **Block /** 🗣 | **Klahn, Kumari** |
| **Exams** | | | | | |
| **ST 2026** | **7241020** | Additive Manufacturing for Process Engineering - Examination | | | **Klahn** |
| **WT 26/27** | **7241020** | Additive Manufacturing for Process Engineering - Examination | | | **Klahn** |

Legend: 📱 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Oral examination lasting approx. 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 6.2 Module component: Advanced Scientific Methods [T-CIWVT-115020]

**Coordinators:** Prof. Dr.-Ing. Alexander Grünberger
**Organisation:** KIT Department of Chemical and Process Engineering
**Part of:** M-CIWVT-107667 - Advanced Scientific Methods

| Type | Credits | Grading | Term offered | Version |
|---|---|---|---|---|
| Coursework | 2 CP | pass/fail | Each summer term | 1 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2213070** | Advanced Scientific Methods | **1.5 SWS** | **Seminar / 🗣** | **Grünberger** |
| **Exams** | | | | | |
| **ST 2026** | **7213070** | Advanced Scientific Methods | | | **Grünberger** |

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None.

## T 6.3 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 2026** | **2211330** | Alternative Protein Technologies | **2 SWS** | **Block /** 🗣 | **Emin** |
| **Exams** | | | | | |
| **ST 2026** | **7211330** | Alternative Protein Technologies | | | **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 6.4 Module component: B2B Sales Management [T-WIWI-111367]

**Coordinators:** Prof. Dr. Martin Klarmann
**Organisation:** KIT Department of Business and Economics
**Part of:** M-WIWI-107904 - B2B Sales Management

| Type | Credits | Grading | Term offered | Version |
|---|---|---|---|---|
| Examination of another type | 4 CP | graded | Each winter term | 2 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2572187** | B2B Sales Management | **2 SWS** | **Lecture /** 🗣 | **Klarmann** |
| **WT 26/27** | **2572188** | Excercises B2B Sales Management | **1 SWS** | **Practice /** 🗣 | **Daumann, Weber** |
| **Exams** | | | | | |
| **ST 2026** | **7900021** | B2B Sales Management | | | **Klarmann** |
| **WT 26/27** | **7900125** | B2B Sales Management | | | **Klarmann** |

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
The assessment of success takes place through the preparation and presentation of a sales presentation based on a case study (max 30 points) and a written exam with additional aids in the sense of an open book exam (max. 60 points). In total, a maximum of 90 points can be achieved in the course. Further details will be announced during the lecture.

**Prerequisites**
None.

**Additional Information**
For further information, please contact Marketing and Sales Research Group (marketing.iism.kit.edu).

**Workload**
135 hours

# T 6.5 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 6.6 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 | 5 CP | graded | Each winter term | 3 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2304240** | Batteries, Fuel Cells and Electrolysis | **2 SWS** | **Lecture /** | **Krewer** |
| **WT 26/27** | **2304241** | Practical Exercise to 2304240 Batteries, Fuel Cells and Electrolysis | **2 SWS** | **Practice /** | **Krewer, Sonder** |
| **Exams** | | | | | |
| **ST 2026** | **7304240** | Batteries, Fuel Cells, and Electrolysis | | | **Krewer** |
| **WT 26/27** | **7304240** | Batteries, Fuel Cells, and Electrolysis | | | **Krewer** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Success control takes place in the form of a graded 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

The following module components **must** have started:

- T-ETIT-114957 - Batteries, Fuel Cells, and Electrolysis - Group Project

**Modeled Prerequisites**
The following conditions have to be fulfilled:

1. The module component T-ETIT-114957 - Batteries, Fuel Cells, and Electrolysis - Group Project must have been started.

**Additional Information**
For details on content and qualification objectives see "M-ETIT-107005 - Batteries, Fuel Cells, and Electrolysis".
The course is offered in English.

**Workload**
150 hours

# T 6.7 Module component: Batteries, Fuel Cells, and Electrolysis - Group Project [T-ETIT-114957]

**Coordinators:** Prof. Dr.-Ing. Ulrike Krewer
**Organisation:** KIT Department of Electrical Engineering and Information Technology
KIT Department of Mechanical Engineering
**Part of:** M-ETIT-107005 - Batteries, Fuel Cells, and Electrolysis

| Type | Credits | Grading | Term offered | Version |
|---|---|---|---|---|
| Coursework | 1 CP | pass/fail | Each winter term | 1 |

| Exams | | | |
|---|---|---|---|
| **ST 2026** | **7304245** | Batteries, Fuel Cells, and Electrolysis - Group Project | **Krewer** |
| **WT 26/27** | **7304241** | Batteries, Fuel Cells, and Electrolysis - Group Project | **Krewer** |

**Assessment**
Success control takes place in the form of an ungraded written technical report (approx. 7-10 pages).

**Prerequisites**
none

**Additional Information**
For details on content and qualification objectives see "M-ETIT-107005 - Batteries, Fuel Cells, and Electrolysis".

The course is offered in English.

**Workload**
30 hours

# T 6.8 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 26/27** | **2212820** | Biobased Plastics | **2 SWS** | **Lecture /** | **Kindervater, Syldatk, Schmiedl** |
| **Exams** | | | | | |
| **ST 2026** | **7212820-VT-BK** | Biobased Plastics | | | **Kindervater** |
| **WT 26/27** | **7212820-VT-BK** | Biobased Plastics | | | **Kindervater** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is a written exam lasting 90 minutes.

**Prerequisites**
None

# T 6.9 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 2026** | **2233820** | Biofilm Systems | **2 SWS** | **Lecture /** | **Hille-Reichel, Wagner** |
| **Exams** | | | | | |
| **ST 2026** | **7233820** | Biofilm Systems | | | **Horn, Hille-Reichel, Wagner** |
| **WT 26/27** | **7233820** | Biofilm Systems | | | **Hille-Reichel, Wagner** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Oral exam, about 20 min.

# T 6.10 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 26/27** | **2141864** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I | **2 SWS** | **Lecture /** 🗣 | **Guber** |
| **Exams** | | | | | |
| **ST 2026** | **76-T-MACH-100966** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I | | | **Guber** |
| **WT 26/27** | **76-T-MACH-100966** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I | | | **Guber** |

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 6.11 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 2026** | **2142883** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II | **2 SWS** | **Lecture /** 🗣 | **Guber, Ahrens** |
| **Exams** | | | | | |
| **ST 2026** | **76-T-MACH-100967** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II | | | **Guber** |
| **WT 26/27** | **76-T-MACH-100967** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II | | | **Guber** |

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 6.12 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 2026** | **2142879** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III | **2 SWS** | **Lecture /** 🗣 | **Guber, Ahrens** |
| **Exams** | | | | | |
| **ST 2026** | **76-T-MACH-100968** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III | | | **Guber** |
| **WT 26/27** | **76-T-MACH-100968** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III | | | **Guber** |

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 6.13 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 | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2141102** | BioMEMS IV - Microsystems technology for Life Sciences and Medicine | **2 SWS** | **Lecture /** 🗣 | **Guber, Ahrens** |
| **Exams** | | | | | |
| **ST 2026** | **76-T-MACH-106877** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV | | | **Guber, Ahrens** |
| **WT 26/27** | **76-T-MACH-106877** | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV | | | **Guber, Ahrens** |

Legend: 🖳 Online, 🖳🗣 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Oral examination (approx. 45 Min.)

**Prerequisites**
none

**Additional Information**
The course is offered in German

**Workload**
120 hours

## T 6.14 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dahmen, Franzreb, Grünberger, Holtmann, Horn, Hubbuch, van der Schaaf** |
| **WT 26/27** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dozierende der KIT-Fakultät** |
| **Exams** | | | | | |
| **ST 2026** | **7200321** | Biopharmaceutical Process Engineering - Research Internship Master BIW | | | **Hubbuch** |
| **WT 26/27** | **7200321** | Biopharmaceutical Process Engineering - Research Internship Master BIW | | | **Hubbuch** |

Legend: 🖥 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

# T 6.15 Module component: Biopharmaceutical Purification Processes [T-CIWVT-114959]

**Coordinators:** Prof. Dr. Jürgen Hubbuch
**Organisation:** KIT Department of Chemical and Process Engineering
**Part of:** M-CIWVT-107629 - Biopharmaceutical Purification Processes

| Type | Credits | Grading | Version |
|---|---|---|---|
| Oral examination | 6 CP | graded | 1 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2214010** | Biopharmaceutical Purification Processes | **3 SWS** | **Lecture /** 🗣 | **Hubbuch, Franzreb** |
| **WT 26/27** | **2214011** | Exercises on 2214010 Biopharmaceutical Purification Processes | **1 SWS** | **Practice /** 🗣 | **Hubbuch, Franzreb** |
| **Exams** | | | | | |
| **ST 2026** | **7214011** | Biopharmaceutical Purification Processes | | | **Hubbuch** |
| **WT 26/27** | **7214011** | Biopharmaceutical Purification Processes (oral exam) | | | **Hubbuch** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control ist an oral exam lasting approx. 20 minutes.

# T 6.16 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 26/27** | **2213040** | Bioprocess Scale-Up | **2 SWS** | **Lecture /** | **Grünberger** |
| **WT 26/27** | **2213041** | Exercises to 2213040 Bioprocess Scale-Up | **2 SWS** | **Practice /** | **Grünberger** |
| **Exams** | | | | | |
| **ST 2026** | **7213040** | Bioprocess Scale-up | | | **Grünberger** |
| **WT 26/27** | **7213040** | Bioprocess Scale-up | | | **Grünberger** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.17 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 2026** | **2210020** | Team Project "99€ Bioreactor": Development of an Innovative Bioreactor Concept | **2 SWS** | **Project / ✕** | **Grünberger, Holtmann** |
| **Exams** | | | | | |
| **ST 2026** | **7210020-BRE** | Bioreactor Development | | | **Holtmann, Grünberger** |

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

**Prerequisites**
None

# T 6.18 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 2026** | **2214810** | Biosensors | **2 SWS** | **Lecture /** | **Kabay** |
| **WT 26/27** | **2214810** | Biosensors | **2 SWS** | **Lecture /** | **Kabay** |
| **Exams** | | | | | |
| **ST 2026** | **7214810** | Biosensors | | | **Kabay** |
| **WT 26/27** | **7200070** | Biosensors | | | **Kabay** |
| **WT 26/27** | **7214810** | Biosensors | | | **Kabay** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Prerequisites**
None

## T 6.19 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 26/27** | **2212210** | Biotechnological Use of Renewable Resources | **2 SWS** | **Lecture /** 🗣 | **Syldatk** |
| **Exams** | | | | | |
| **ST 2026** | **7212210-VT-BR** | Biotechnology in Bioeconomy | | | **Syldatk** |
| **WT 26/27** | **7212210-VT-BR** | Biotechnological Use of Renewable Resources | | | **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 6.20 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 26/27** | **2212130** | C1-Biotechnology | **2 SWS** | **Lecture /** | **Neumann** |
| **WT 26/27** | **2212131** | Exercises on 2212130 C1-Biotechnology | **1 SWS** | **Practice /** | **Neumann** |
| **Exams** | | | | | |
| **ST 2026** | **7212130-VL-C1** | C1-Biotechnology Exam | | | **Neumann** |
| **WT 26/27** | **7212130-VL-C1** | C1-Biotechnology Exam | | | **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 6.21 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 26/27** | **2212130** | C1-Biotechnology | **2 SWS** | **Lecture /** 🗣 | **Neumann** |
| **WT 26/27** | **2212131** | Exercises on 2212130 C1-Biotechnology | **1 SWS** | **Practice /** 🗣 | **Neumann** |
| **Exams** | | | | | |
| **WT 26/27** | **7212131-Pr-C1** | C1-Biotechnology Presentation | | | **Neumann** |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

# T 6.22 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 2026** | **2212810** | Commercial Biotechnology | **2 SWS** | **Lecture /** 🗣 | **Kindervater, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7212810-VT-KB** | Commercial Biotechnology | | | **Kindervater** |
| **WT 26/27** | **7212810-VT-KB** | Commercial Biotechnology | | | **Kindervater** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is a written exam lasting 60 minutes.

**Prerequisites**
None

# T 6.23 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 26/27** | **2245020** | Computational Fluid Dynamics | **2 SWS** | **Lecture /** | **Nirschl, und Mitarbeitende** |
| **WT 26/27** | **2245021** | Exercises for 2245020 Computational Fluid Dynamics | **1 SWS** | **Practice /** | **Nirschl, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7245020** | Computational Fluid Dynamics | | | **Nirschl** |
| **WT 26/27** | **7245020** | Computational Fluid Dynamics | | | **Nirschl** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is a written examination lasting 90 minutes.

**Prerequisites**
None

## T 6.24 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 2026** | **0161700** | Computational Fluid Dynamics and Simulation Lab | **4 SWS** | **Practical course** | **Thäter, Krause, Simonis** |
| **Exams** | | | | | |
| **ST 2026** | **7700120** | Computational Fluid Dynamics and Simulation Lab | | | **Thäter** |

**Prerequisites**
none

**Workload**
120 hours

# T 6.25 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 26/27** | **2243070** | Data-Based Modeling and Control | **3 SWS** | **Lecture / Practice /** | **Meurer** |
| **Exams** | | | | | |
| **ST 2026** | **7243070** | Data-Based Modeling and Control | | | **Meurer** |
| **WT 26/27** | **7243070** | Data-Based Modeling and Control | | | **Meurer** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.26 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dahmen, Franzreb, Grünberger, Holtmann, Horn, Hubbuch, van der Schaaf** |
| **WT 26/27** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dozierende der KIT-Fakultät** |
| **Exams** | | | | | |
| **ST 2026** | **7200322** | Data-Driven Methods in Bioengineering: Modeling and Autonomous Experimentation - Research Internship Master BIW | | | **Franzreb** |
| **WT 26/27** | **7200322** | Data-Driven Methods in Bioengineering: Modeling and Autonomous Experimentation - Research Internship Master BIW | | | **Franzreb** |

Legend: 🖥 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

# T 6.27 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 26/27** | **2245320** | Data-Driven Modeling with Python | **2 SWS** | **Lecture /** | **Rhein** |
| **WT 26/27** | **2245321** | Project Work on 2245320 Data-Driven Modeling with Python | **1 SWS** | **Practice /** | **Rhein** |
| **Exams** | | | | | |
| **ST 2026** | **7245321** | Data-Driven Modeling with Python - Project | | | **Rhein** |
| **WT 26/27** | **7245321** | Data-Driven Modeling with Python - Project | | | **Rhein** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.28 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 |

| Exams | | | |
|---|---|---|---|
| **ST 2026** | **7245320** | Data-Driven Process Engineering Models in Python - Exam | **Rhein** |
| **WT 26/27** | **7245320** | Data-Driven Process Engineering Models in Python - Exam | **Rhein** |

**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 6.29 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 2026** | **2400024** | Deep Learning and Neural Networks | **4 SWS** | **Lecture /** 🗣 | **Niehues** |
| **Exams** | | | | | |
| **ST 2026** | **7500044** | Deep Learning and Neural Networks | | | **Niehues** |
| **WT 26/27** | **7500400** | Deep Learning and Neural Networks (Nachklausur) | | | **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 6.30 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 2026** | **2211220** | Team Project "Eco TROPHELIA": Development of an Innovative Food Product | **3 SWS** | **Project /** 🗣 | **van der Schaaf, und Mitarbeitende** |
| **WT 26/27** | **2211220** | Team Project "Eco TROPHELIA": Development of an Innovative Food Product | **3 SWS** | **Project /** 🗣 | **van der Schaaf, Ellwanger** |
| **Exams** | | | | | |
| **ST 2026** | **7211220** | Development of an Innovative Food Product - presentation | | | **van der Schaaf** |
| **WT 26/27** | **7211220** | Development of an Innovative Food Product | | | **van der Schaaf** |

Legend: 🖥 Online, 🌍 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Learning control is an examination of another type: a written elaboration

**Prerequisites**
None

# T 6.31 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 2026** | **2211220** | Team Project "Eco TROPHELIA": Development of an Innovative Food Product | **3 SWS** | **Project /** 🗣 | **van der Schaaf, und Mitarbeitende** |
| **WT 26/27** | **2211220** | Team Project "Eco TROPHELIA": Development of an Innovative Food Product | **3 SWS** | **Project /** 🗣 | **van der Schaaf, Ellwanger** |
| **Exams** | | | | | |
| **ST 2026** | **7211221** | Development of an Innovative Food Product | | | **van der Schaaf** |
| **WT 26/27** | **7211221** | Development of an Innovative Food Product | | | **van der Schaaf** |

Legend: 💻 Online, 🌍 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Learning control is an examination of another type: Seminar/ Presentation.

**Prerequisites**
None

## T 6.32 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 26/27** | **2241031** | Practical Course Digital Design in Process Engineering | **2 SWS** | **Practical course /** 🗣 | **Klahn, Zimmer** |
| **Exams** | | | | | |
| **WT 26/27** | **7241031** | Digital Design in Process Engineering - Laboratory | | | **Klahn** |

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Laboratory, ungraded.

**Prerequisites**
None.

# T 6.33 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 26/27** | **2241030** | Digital Design in Process Engineering | **2 SWS** | **Lecture /** 🗣 | **Klahn** |
| **Exams** | | | | | |
| **ST 2026** | **7241030** | Digital Design in Process Engineering - Oral Examination | | | **Klahn** |
| **WT 26/27** | **7241030** | Digital Design in Process Engineering - Oral Examination | | | **Klahn** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**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 6.34 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 26/27** | **2245220** | Digitization in Particle Technology | **2 SWS** | **Lecture /** 🗣 | **Gleiß, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7245220** | Digitization in particle technology | | | **Gleiß** |
| **WT 26/27** | **7245220** | Digitization in Particle Technology | | | **Gleiß** |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
None

## T 6.35 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 26/27** | **2245221** | Project Work on 2245220 Digitization in Particle Technology | **1 SWS** | **Project / 🗣** | **Gleiß, und Mitarbeitende** |
| **Exams** | | | | | |
| **WT 26/27** | **7245221** | Digitization in Particle Technology - Project Work | | | **Gleiß** |

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

# T 6.36 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 2026** | **2243120** | Dynamics of Process Engineering Systems | **2 SWS** | **Lecture /** 🗣 | **Jerono** |
| **ST 2026** | **2243121** | Dynamics of Process Engineering Systems - Exercises | **1 SWS** | **Practice /** 🗣 | **Jerono** |
| **Exams** | | | | | |
| **ST 2026** | **7243120** | Dynamics of Process Engineering Systems - Exam | | | **Jerono** |
| **WT 26/27** | **7243120** | Dynamics of Process Engineering Systems - Exam | | | **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 6.37 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 2026** | **2243120** | Dynamics of Process Engineering Systems | **2 SWS** | **Lecture /** 🗣 | **Jerono** |
| **ST 2026** | **2243121** | Dynamics of Process Engineering Systems - Exercises | **1 SWS** | **Practice /** 🗣 | **Jerono** |
| **Exams** | | | | | |
| **ST 2026** | **7243121** | Dynamics of Process Engineering Systems - Prerequisite | | | **Jerono** |
| **WT 26/27** | **7243121** | Dynamics of Process Engineering Systems - Prerequisite | | | **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 6.38 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 6.39 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 6.40 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 6.41 Module component: Electrification of Process Industry [T-CIWVT-115000]

**Coordinators:** Prof. Dr.-Ing. Frederik Scheiff
**Organisation:** KIT Department of Chemical and Process Engineering
**Part of:** M-CIWVT-107653 - Electrification of the Process Industry

| Type | Credits | Grading | Version |
|---|---|---|---|
| Oral examination | 4 CP | graded | 1 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2231030** | Electrification of the Process Industry | **2 SWS** | **Lecture /** | **Scheiff** |
| **Exams** | | | | | |
| **ST 2026** | **7231030** | Electrification of Process Industry | | | **Scheiff** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is an oral exam lasting approx. 25 minutes.

**Prerequisites**
None.

# T 6.42 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 26/27** | **2212010** | Electrobiotechnology | **0 SWS** | **Lecture / ✕** | **Holtmann** |
| **WT 26/27** | **2212011** | Electrobiotechnology - Exercises | **0 SWS** | **Seminar / ✕** | **Holtmann** |
| **Exams** | | | | | |
| **ST 2026** | **7212010-VT-EBT** | Electrobiotechnology | | | **Holtmann** |
| **WT 26/27** | **7212010-VT-EBT** | Electrobiotechnology | | | **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 6.43 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 26/27** | **2212010** | Electrobiotechnology | **0 SWS** | **Lecture / ✕** | **Holtmann** |
| **WT 26/27** | **2212011** | Electrobiotechnology - Exercises | **0 SWS** | **Seminar / ✕** | **Holtmann** |
| **Exams** | | | | | |
| **ST 2026** | **7212011-S-EBT** | Electrobiotechnology Seminar | | | **Holtmann** |
| **WT 26/27** | **7212011-S-EBT** | Electrobiotechnology Seminar | | | **Holtmann** |

Legend: Online, Blended (On-Site/Online), On-Site, ✕ Cancelled

# T 6.44 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 | 6 CP | graded | Each summer term | 3 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2304300** | Electrocatalysis | **3 SWS** | **Lecture /** 🗣 | **Röse** |
| **ST 2026** | **2304301** | Exercise to 2304300 Electrocatalysis | **1 SWS** | **Practice /** 🗣 | **Röse** |
| **Exams** | | | | | |
| **ST 2026** | **7304300** | Electrocatalysis | | | **Röse** |
| **WT 26/27** | **7300072** | Electrocatalysis | | | **Röse** |

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
none

# T 6.45 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 |

| Exams | | | |
|---|---|---|---|
| **ST 2026** | **7100101EC** | Electrochemistry | **Schuster, Bresser** |
| **ST 2026** | **7100101EC_2** | Electrochemistry | **Schuster, Bresser** |

**Prerequisites**
none

# T 6.46 Module component: Emulsification Technology [T-CIWVT-114611]

**Coordinators:** 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2211230** | Emulsion Technology | **2 SWS** | **Lecture /** | **van der Schaaf** |
| **Exams** | | | | | |
| **ST 2026** | **7211230** | Emulsification Technology | | | **van der Schaaf** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.47 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 26/27** | **2231510** | Biomass Based Energy Carriers | **2 SWS** | **Lecture /** 🗣 | **Bajohr** |
| **WT 26/27** | **2231511** | Exercises on 2231510 Biomass Based Energy Carriers | **1 SWS** | **Practice /** 🗣 | **Bajohr, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7231510** | Energy from Biomass | | | **Bajohr** |
| **WT 26/27** | **7231510** | Energy from Biomass | | | **Bajohr** |

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
None

# T 6.48 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 26/27** | **2141875** | Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics | **2 SWS** | **Lecture /** 🗣 | **Nesterov-Müller** |
| **Exams** | | | | | |
| **ST 2026** | **76-T-MACH-114731** | Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics | | | |
| **WT 26/27** | **76-T-MACH-114731** | Engineering High-Density Molecular Arrays: Tools, Techniques, and AI-Driven Solutions for Biomedical Diagnostics | | | |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
written exam Duration of Examination: 60 Minutes

**Prerequisites**
none

**Workload**
120 hours

# T 6.49 Module component: Excursions: Water Supply [T-CIWVT-110866]

**Coordinators:** Dr. Andrea Hille-Reichel
**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 |

| Exams | | | |
|---|---|---|---|
| **WT 26/27** | **7233033** | Excursions: Water Supply | **Hille-Reichel** |

# T 6.50 Module component: Exercises: Membrane Technologies [T-CIWVT-113235]

**Coordinators:** 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 2026** | **2233011** | Membrane Technologies in Water Treatment - Excercises | **1 SWS** | **Practice /** | **Horn, Saravia, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7233011** | Exercises for Membrane Technologies | | | **Horn, Saravia** |

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 6.51 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 26/27** | **2211310** | Extrusion Technology in Food Processing | **2 SWS** | **Block /** 🗣 | **Emin** |
| **Exams** | | | | | |
| **ST 2026** | **7211310** | Extrusion Technology in Food Processing | | | **Emin** |
| **WT 26/27** | **7211310** | Extrusion Technology in Food Processing | | | **Emin** |

Legend: 💻 Online, 🌐 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
None.

# T 6.52 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 2026** | **6601** | Grundlagen der Lebensmittelchemie I | **2 SWS** | **Lecture /** 🗣 | **Bunzel** |
| **Exams** | | | | | |
| **ST 2026** | **71109442** | Food Chemistry Basics | | | **Bunzel** |
| **WT 26/27** | **71109442** | Food Chemistry Basics | | | **Bunzel** |

Legend: 🖥 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None

# T 6.53 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dahmen, Franzreb, Grünberger, Holtmann, Horn, Hubbuch, van der Schaaf** |
| **WT 26/27** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dozierende der KIT-Fakultät** |
| **Exams** | | | | | |
| **ST 2026** | **7200324** | Food Process Engineering - Research Internship Master BIW | | | **van der Schaaf** |
| **WT 26/27** | **7200324** | Food Process Engineering - Research Internship Master BIW | | | **van der Schaaf** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

## T 6.54 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 26/27** | **2214030** | Formulation of (Bio)pharmaceutical Therapeutics | **2 SWS** | **Lecture /** 🗣 | **Hubbuch** |
| **Exams** | | | | | |
| **ST 2026** | **7214030** | Formulation of (Bio)pharmaceutical Therapeutics | | | **Hubbuch** |
| **WT 26/27** | **7214030** | Formulation of (Bio)pharmaceutical Therapeutics | | | **Hubbuch** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is an oral exam lasting approx. 15 minutes.

**Prerequisites**
None

# T 6.55 Module component: Fundamentals of Water Quality [T-CIWVT-106838]

**Coordinators:** Prof. Dr.-Ing. Marta Markiewicz
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 26/27** | **2233230** | Fundamentals of Water Quality | **2 SWS** | **Lecture /** 🗣 | **Wagner, Markiewicz** |
| **WT 26/27** | **2233231** | Fundamentals of Water Quality - Exercises | **1 SWS** | **Practice /** 🗣 | **Wagner, Markiewicz, und Mitarbeitende** |
| **Exams** | | | | | |
| **WT 26/27** | **7233230** | Fundamentals of Water Quality | | | **Wagner** |

Legend: 💻 Online, 🌸 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Learning control ist an oral exam lasting approx. 20 minutes.

**Prerequisites**
None.

# T 6.56 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dahmen, Franzreb, Grünberger, Holtmann, Horn, Hubbuch, van der Schaaf** |
| **WT 26/27** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dozierende der KIT-Fakultät** |
| **Exams** | | | | | |
| **ST 2026** | **7200323** | Gas Fermentation - Research Internship Master BIW | | | **Dahmen** |
| **WT 26/27** | **7200323** | Gas Fermentation - Research Internship Master BIW | | | **Dahmen** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.57 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 26/27** | **2260010** | Heat Exchangers | **2 SWS** | **Lecture /** | **Wetzel** |
| **WT 26/27** | **2260011** | Exercise on 2260010 Heat Exchangers | **1 SWS** | **Practice /** | **Wetzel** |
| **Exams** | | | | | |
| **ST 2026** | **7260010** | Heat Exchangers | | | **Wetzel** |
| **WT 26/27** | **7260010** | Heat Exchangers | | | **Wetzel** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**Prerequisites**
None

# T 6.58 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 2026** | **2232030** | Hydrogen and Fuel Cell Technologies | **2 SWS** | **Lecture /** 🗣 | **Trimis** |
| **Exams** | | | | | |
| **ST 2026** | **7232030** | Hydrogen and Fuel Cell Technologies | | | **Trimis** |
| **WT 26/27** | **7232030** | Hydrogen and Fuel Cell Technologies | | | **Trimis** |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None

## T 6.59 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 2026** | **2214020** | Industrial Aspects in Bioprocess Technology | **2 SWS** | **Lecture /** 🗣 | **Hubbuch** |
| **Exams** | | | | | |
| **ST 2026** | **7214020** | Industrial Aspects in Bioprocess Technology | | | **Hubbuch** |
| **WT 26/27** | **7214020** | Industrial Aspects in Bioprocess Technology | | | **Hubbuch** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control ist an oral exam lasting approx. 15 minutes.

**Prerequisites**
None

# T 6.60 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 2026** | **2212230** | Industrial Biocatalysis | **2 SWS** | **Lecture /** | **Rudat** |
| **Exams** | | | | | |
| **ST 2026** | **7212230-VT-IBK** | Industrial Biocatalysis | | | **Rudat** |
| **WT 26/27** | **7212230_VT-IBK** | Industrial Biocatalysis | | | **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 6.61 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 26/27** | **2245810** | Industrial Bioprocesses | **2 SWS** | **Lecture /** | **Kopf** |
| **Exams** | | | | | |
| **ST 2026** | **7245810** | Industrial bioprocesses | | | **Kopf** |
| **WT 26/27** | **7245810** | Industrial bioprocesses | | | **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 6.62 Module component: Industrial Wastewater Treatment [T-CIWVT-111861]

**Coordinators:** Prof. Dr.-Ing. Marta Markiewicz
**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 2026** | **2233020** | Industrial Wastewater Treatment | **2 SWS** | **Lecture /** | **Horn** |
| **Exams** | | | | | |
| **ST 2026** | **7233020** | Industrial Wastewater Treatment | | | **Horn** |
| **WT 26/27** | **7233020** | Industrial Wastewater Treatment | | | **Markiewicz** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**Prerequisites**
None

# T 6.63 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 2026** | **2231330** | Innovation Management for Products and Processes in the Chemical Industry | **2 SWS** | **Block /** 🗣 | **Sauer, Neumann** |
| **WT 26/27** | **2231330** | Innovation Management for Products and Processes in the Chemical Industry - Announcement | | **Block /** 💮 | **Sauer, Neumann** |
| **Exams** | | | | | |
| **ST 2026** | **7231330** | Innovation Management for Products and Processes in the Chemical Industry | | | **Neumann** |
| **WT 26/27** | **7231330** | Innovation Management for Products & Processes in the Chemical Industry | | | **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 6.64 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dahmen, Franzreb, Grünberger, Holtmann, Horn, Hubbuch, van der Schaaf** |
| **WT 26/27** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dozierende der KIT-Fakultät** |
| **Exams** | | | | | |
| **ST 2026** | **7200320-FP-BIW** | Intensification of Bio-Processes - Research Internship Master BIW | | | **Holtmann** |
| **WT 26/27** | **7200320-FP-BIW** | Intensification of Bio-Processes - Research Internship Master BIW | | | **Holtmann** |

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None

# T 6.65 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 |

| Exams | | | |
|---|---|---|---|
| **ST 2026** | **7200000** | Internship | **Bajohr** |
| **WT 26/27** | **7200000** | Internship | **Bajohr** |

**Prerequisites**
None

# T 6.66 Module component: Introduction to Artificial Intelligence [T-INFO-112194]

**Coordinators:** Prof. Dr. Pascal Friederich
Prof. Dr. Gerhard Neumann
**Organisation:** KIT Department of Informatics
**Part of:** M-INFO-106014 - Introduction to Artificial Intelligence

| Type | Credits | Grading | Term offered | Version |
|---|---|---|---|---|
| Written examination | 6 CP | graded | Each winter term | 9 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2400158** | Introduction to Artificial Intelligence | **3 SWS** | **Lecture / Practice /** 🗣 | **Schäfer, Nowack, Friederich, Neumann** |
| **Exams** | | | | | |
| **ST 2026** | **7500058** | Introduction to Artificial Intelligence | | | **Friederich, Schäfer, Nowack** |
| **WT 26/27** | **7500136** | Introduction to Artificial Intelligence | | | **Friederich, Neumann, Schäfer, Nowack** |

Legend: 📱 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

# T 6.67 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 26/27** | **2232130** | Introduction to Numerical Simulation of Reacting Flows | **2 SWS** | **Lecture /** 🗣 | **Stein** |
| **WT 26/27** | **2232131** | Introduction to Numerical Simulation of Reacting Flows - Exercises | **2 SWS** | **Practice /** 🗣 | **Stein** |
| **Exams** | | | | | |
| **ST 2026** | **7232130** | Introduction to Numerical Simulation of Reacting Flows | | | **Stein** |
| **WT 26/27** | **7232130** | Introduction to Numerical Simulation of Reacting Flows | | | **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 6.68 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 26/27** | **2232130** | Introduction to Numerical Simulation of Reacting Flows | **2 SWS** | **Lecture /** | **Stein** |
| **WT 26/27** | **2232131** | Introduction to Numerical Simulation of Reacting Flows - Exercises | **2 SWS** | **Practice /** | **Stein** |
| **Exams** | | | | | |
| **ST 2026** | **7232131** | Introduction to Numerical Simulation of Reacting Flows - Prerequisite | | | **Stein** |
| **WT 26/27** | **7232131** | Introduction to Numerical Simulation of Reacting Flows - Prerequisite | | | **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 6.69 Module component: Introduction to Sensory Analysis with Practice [T-CIWVT-109128]

**Coordinators:** Prof. Dr. Mirko Bunzel
**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 2026** | **6630** | Einführung in die Sensorik mit Übungen | **1 SWS** | **Lecture /** | **N.N., Bunzel** |
| **Exams** | | | | | |
| **ST 2026** | **7206630** | Introduction to Sensory Analysis with Practice | | | **Bunzel** |
| **WT 26/27** | **7206630** | Introduction to Sensory Analysis with Practice | | | **Hofsäß** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Prerequisites**
None

# T 6.70 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 | 2 CP | graded | Each winter term | 2 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2212040** | Journal Club – Novel Bioproduction Systems | **2 SWS** | **Seminar / 🗣** | **Holtmann** |
| **Exams** | | | | | |
| **ST 2026** | **7212040-VT-JC** | Journal Club - Novel Bioproduction Systems | | | **Holtmann** |
| **WT 26/27** | **7212040-VT-JC** | Journal Club - Novel Bioproduction Systems | | | **Holtmann** |

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None.

# T 6.71 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 summer term | 2 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2220030** | Kinetics and Catalysis | **2 SWS** | **Lecture /** | **Wehinger, und Mitarbeitende** |
| **ST 2026** | **2220031** | Kinetics and Catalysis - Exercises | **1 SWS** | **Practice /** | **Wehinger, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7220030** | Kinetics and Catalysis | | | **Wehinger** |
| **WT 26/27** | **7220030** | Kinetics and Catalysis | | | **Wehinger** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is a written examination lasting 90 minutes.

**Prerequisites**
None

# T 6.72 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 26/27** | **2245130** | NMR for Engineers | **2 SWS** | **Lecture /** | **Guthausen** |
| **WT 26/27** | **2245131** | Laboratory Work for 2245130 NMR for Engineers | **2 SWS** | **Practical course /** | **Guthausen** |
| **Exams** | | | | | |
| **WT 26/27** | **7245131** | Laboratory Work for NMR for Engineers | | | **Guthausen** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is an ungraded lab-course.

**Prerequisites**
None

# T 6.73 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **1130716** | Lecture Series Science in Society | **2 SWS** | **Lecture /** 🗣 | **Post, Mielke** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**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 6.74 Module component: Managing the Marketing Mix [T-WIWI-102805]

**Coordinators:** Prof. Dr. Martin Klarmann
**Organisation:** KIT Department of Business and Economics
**Part of:** M-WIWI-107905 - Managing the Marketing Mix

| Type | Credits | Grading | Term offered | Version |
|---|---|---|---|---|
| Examination of another type | 4 CP | graded | Each summer term | 3 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2571152** | Managing the Marketing Mix | **2 SWS** | **Lecture /** 🗣 | **Klarmann** |
| **ST 2026** | **2571153** | Übung zu Marketing Mix (Bachelor) | **1 SWS** | **Practice /** 🗣 | **Daumann, Weber** |
| **Exams** | | | | | |
| **ST 2026** | **7900023** | Managing the Marketing Mix | | | **Klarmann** |
| **WT 26/27** | **7900061** | Managing the Marketing Mix | | | **Klarmann** |

Legend: 💻 Online, 🗣💻 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
The assessment of success takes place through the preparation and presentation of a case study (max. 30 points) as well as a written exam with additional aids in the sense of an open book exam (max. 60 points). In total, a maximum of 90 points can be achieved in the course. Further details will be announced during the lecture.

**Prerequisites**
None

**Additional Information**
The course is compulsory in the module "Foundations of Marketing".
For further information please contact Marketing & Sales Research Group (marketing.iism.kit.edu).

**Workload**
135 hours

# T 6.75 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 - 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 6.76 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 2026** | **2245840** | Materials and Processes for Electrochemical Storage | **2 SWS** | **Lecture /** 🗣 | **Tübke** |
| **Exams** | | | | | |
| **ST 2026** | **7245840** | Materials and Processes for Electrochemical Storage | | | **Tübke** |
| **WT 26/27** | **7245840** | Materials for Electrochemical Storage | | | **Tübke** |

Legend: 💻 Online, 🔀 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
None

# T 6.77 Module component: Membrane Technologies in Water Treatment [T-CIWVT-113236]

**Coordinators:** 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 2026** | **2233010** | Membrane Technologies in Water Treatment | **2 SWS** | **Lecture /** | **Horn, Saravia** |
| **ST 2026** | **2233011** | Membrane Technologies in Water Treatment - Excercises | **1 SWS** | **Practice /** | **Horn, Saravia, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7233010** | Membrane Technologies in Water Treatment | | | **Horn, Saravia** |
| **WT 26/27** | **7233010** | Membrane Technologies in Water Treatment | | | **Saravia** |

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 - Exercises: Membrane Technologies must have been passed.

# T 6.78 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 26/27** | **2245410** | Microfluidics - Basics and Applications | **2 SWS** | **Lecture /** 🗣 | **Leneweit** |
| **Exams** | | | | | |
| **ST 2026** | **7245410** | Microfluidics | | | **Leneweit** |
| **WT 26/27** | **7245410** | Microfluidics | | | **Leneweit** |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
None

# T 6.79 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 26/27** | **2245411** | Case Studies in Microfluidics (Practical Course on 2245410) | **1 SWS** | **Practical course /** 🗣 | **Leneweit** |
| **Exams** | | | | | |
| **ST 2026** | **7245411** | Microfluidics - Case Studies | | | **Leneweit** |
| **WT 26/27** | **7245411** | Microfluidics - Case Studies | | | **Leneweit** |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None

# T 6.80 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2213060** | Microsystems in Bioprocess Engineering | **2 SWS** | **Lecture /** | **Grünberger** |
| **Exams** | | | | | |
| **ST 2026** | **7213060** | Microsystems in Bioprocess Engineering | | | **Grünberger** |

Legend: Online, Blended (On-Site/Online), On-Site, Cancelled

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

**Prerequisites**
None

# T 6.81 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 2026** | **2245310** | Mixing, Stirring and Agglomeration | **3 SWS** | **Lecture /** | **Rhein** |
| **Exams** | | | | | |
| **ST 2026** | **7245310** | Mixing, Stirring, Agglomeration | | | **Nirschl, Rhein** |
| **WT 26/27** | **7245310** | Mixing, Stirring, Agglomeration | | | **Nirschl, Rhein** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**Prerequisites**
None

# T 6.82 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2305302** | Modeling Physiological Systems | **2 SWS** | **Lecture /** | **Loewe** |
| **Exams** | | | | | |
| **ST 2026** | **7305302** | Modeling Physiological Systems | | | **Loewe** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**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 6.83 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2305303** | Exercise to 2305302 Modeling Physiological Systems | **2 SWS** | **Practice / 🗣** | **Loewe, Kruthoff** |
| **Exams** | | | | | |
| **ST 2026** | **7305303** | Modeling Physiological Systems - Workshop | | | **Loewe** |

Legend: 📱 Online, 🎛 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Success control takes place in the form of ungraded course works. The workshop tasks (3 exercise sheets) must be submitted.

**Prerequisites**
none

**Additional Information**
This success control must be passed in order to register for the written examination.

# T 6.84 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 26/27** | **7301** | Molekularbiologie (BA-04) | **2 SWS** | **Lecture /** | **Requena Sanchez** |
| **WT 26/27** | **7401** | Genetik (BA-04) | **2 SWS** | **Lecture /** | **Kämper, Kaster** |
| **Exams** | | | | | |
| **ST 2026** | **71103675** | Molecular Biology and Genetics | | | **Requena Sanchez, Fischer, Kämper** |
| **WT 26/27** | **71INF-103675** | Molecular Biology and Genetics | | | **Kämper, Fischer, Requena Sanchez** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Prerequisites**
none

**Workload**
150 hours

# T 6.85 Module component: Multimodal Artificial Intelligence [T-INFO-115041]

**Coordinators:** Prof. Dr. Jan Niehues
Prof. Dr.-Ing. Rainer Stiefelhagen
**Organisation:** KIT Department of Informatics
**Part of:** M-INFO-107676 - Multimodal Artificial Intelligence

| Type | Credits | Grading | Term offered | Version |
|---|---|---|---|---|
| Written examination | 6 CP | graded | Each summer term | 2 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2400141** | Multimodal Artificial Intelligence | **4 SWS** | **Lecture /** 🗣 | **Niehues, Stiefelhagen** |
| **Exams** | | | | | |
| **ST 2026** | **7500402** | Multimodal Artificial Intelligence | | | **Niehues, Stiefelhagen** |
| **WT 26/27** | **7500210** | Multimodal Artificial Intelligence | | | **Stiefelhagen** |

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) approx. 60 minutes.

**Prerequisites**
None.

**Modeled Prerequisites**
The following conditions have to be fulfilled:

1. The module component T-INFO-114220 - Advanced Artificial Intelligence must not have been started.

# T 6.86 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dahmen, Franzreb, Grünberger, Holtmann, Horn, Hubbuch, van der Schaaf** |
| **WT 26/27** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dozierende der KIT-Fakultät** |
| **Exams** | | | | | |
| **ST 2026** | **7200325** | Multiscale Bioengineering - Research Internship Master BIW | | | **Grünberger** |
| **WT 26/27** | **7200325** | Multiscale Bioengineering - Research Internship Master BIW | | | **Grünberger** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.87 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 26/27** | **2245130** | NMR for Engineers | **2 SWS** | **Lecture /** | **Guthausen** |
| **WT 26/27** | **2245131** | Laboratory Work for 2245130 NMR for Engineers | **2 SWS** | **Practical course /** | **Guthausen** |
| **Exams** | | | | | |
| **ST 2026** | **7245130** | NMR for Engineers | | | **Guthausen** |
| **WT 26/27** | **7245130** | NMR for Engineers | | | **Guthausen** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**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 6.88 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 26/27** | **2245130** | NMR for Engineers | **2 SWS** | **Lecture /** | **Guthausen** |
| **Exams** | | | | | |
| **WT 26/27** | **7245130** | NMR for Engineers | | | **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 6.89 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 26/27** | **2243050** | Nonlinear Process Control | **3 SWS** | **Lecture / Practice /** 🗣 | **Meurer** |
| **Exams** | | | | | |
| **ST 2026** | **7243050** | Nonlinear Process Control | | | **Meurer** |
| **WT 26/27** | **7243050** | Nonlinear Process Control | | | **Meurer** |

Legend: 🖥 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None.

# T 6.90 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 2026** | **2232120** | Numerical Simulation of Reacting Multiphase Flows | **2 SWS** | **Lecture /** 🗣 | **Stein** |
| **ST 2026** | **2232121** | Numerical Simulation of Reacting Multiphase Flows - Exercises | **2 SWS** | **Practice /** 🗣 | **Stein, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7232121** | Numerical Simulation of Reacting Multiphase Flows | | | **Stein** |
| **WT 26/27** | **7232121** | Numerical Simulation of Reacting Multiphase Flows | | | **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-114117 - Numerical Simulation of Reacting Multiphase Flows - Prerequisite must have been passed.

# T 6.91 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 2026** | **2232120** | Numerical Simulation of Reacting Multiphase Flows | **2 SWS** | **Lecture /** 🗣 | **Stein** |
| **ST 2026** | **2232121** | Numerical Simulation of Reacting Multiphase Flows - Exercises | **2 SWS** | **Practice /** 🗣 | **Stein, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7232120** | Numerical Simulation of Reacting Multiphase Flows - Prerequisite | | | **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 6.92 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 2026** | **2243030** | Optimal and Model Predictive Control | **2 SWS** | **Lecture /** 🗣 | **Meurer** |
| **ST 2026** | **2243031** | Optimal and Model Predictive Control - Exercises | **1 SWS** | **Practice /** 🗣 | **Meurer** |
| **Exams** | | | | | |
| **ST 2026** | **7243030** | Optimal and Model Predictive Control | | | **Meurer** |
| **WT 26/27** | **7243030** | Optimal and Model Predictive Control | | | **Meurer** |

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

# T 6.93 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 2026** | **2106008** | Organ support systems | **2 SWS** | **Lecture /** 🗣 | **Pylatiuk** |
| **Exams** | | | | | |
| **ST 2026** | **76-T-MACH-105228** | Organ Support Systems | | | **Pylatiuk** |
| **WT 26/27** | **76-T-MACH-105228** | Organ Support Systems | | | **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 6.94 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 | Term offered | Version |
|---|---|---|---|---|
| Oral examination | 6 CP | graded | Irregular | 2 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **0162000** | Paralleles Rechnen in Theorie und Praxis | **2 SWS** | **Lecture** | **Krause, Bülow** |
| **ST 2026** | **0162100** | Übungen zu 0162000 | **2 SWS** | **Practice /** | **Krause, Bülow** |
| **WT 26/27** | **0100055** | Parallel Computing | **3 SWS** | **Lecture** | **Krause, Simonis** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
oral exam lasting approximately 20 minutes.

**Workload**
180 hours

# T 6.95 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 2026** | **2244030** | Particle Technology | **2 SWS** | **Lecture /** | **Dittler** |
| **ST 2026** | **2244031** | Particle Technology - Exercises | **1 SWS** | **Practice /** | **Dittler, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7244030** | Particle Technology Exam | | | **Dittler** |
| **WT 26/27** | **7244030** | Particle Technology Exam | | | **Dittler** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is a written examination lasting 135 minutes (15 minutes reading time and 120 minutes to complete the tasks).

**Prerequisites**
None

# T 6.96 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 | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2210030** | Plant and System Design | **3 SWS** | **Project /** 🗣 | **Holtmann, Grünberger** |
| **WT 26/27** | **2210030** | Plant and System Design | **3 SWS** | **Project /** 🗣 | **Holtmann, Grünberger** |
| **Exams** | | | | | |
| **ST 2026** | **7210030-VT-Projekt** | Plant an System Design | | | **Holtmann, Grünberger** |
| **WT 26/27** | **7210030-VT-Projekt** | Plant an System Design | | | **Holtmann, Grünberger** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.97 Module component: Practical Course in Water Technology [T-CIWVT-106840]

**Coordinators:** Dr. Andrea Hille-Reichel
**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 | 5 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2233032** | Practical Course: Water Quality and Water Assessment | **2 SWS** | **Practical course /** 🗣 | **Hille-Reichel, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7233032** | Practical Course in Water Technology | | | **Horn, Hille-Reichel** |
| **WT 26/27** | **7233032** | Practical Course in Water Technology | | | **Hille-Reichel** |

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 two excursions, 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 6.98 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 2026** | **2241021** | Practical in Additive Manufacturing for Process Engineering | **1 SWS** | **Practical course /** 🗣 | **Klahn** |
| **Exams** | | | | | |
| **ST 2026** | **7241021** | Practical in Additive Manufacturing for Process Engineering | | | **Klahn** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is an ungraded completed coursework: Lab, 8 experiments.

# T 6.99 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 26/27** | **2243060** | Principles of Constrained Static Optimization | **2 SWS** | **Lecture / Practice /** 🗣 | **Meurer, Jerono** |
| **Exams** | | | | | |
| **ST 2026** | **7243060** | Principles of Constrained Static Optimization | | | **Jerono** |
| **WT 26/27** | **7243060** | Principles of Constrained Static Optimization | | | **Jerono** |

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, × Cancelled

# T 6.100 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 | 3 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2105992** | Principles of Medicine for Engineers | **2 SWS** | **Lecture /** 🗣 | **Pylatiuk** |
| **Exams** | | | | | |
| **ST 2026** | **76-T-MACH-105235** | Principles of Medicine for Engineers | | | **Pylatiuk** |
| **WT 26/27** | **76-T-MACH-105235** | Principles of Medicine for Engineers | | | **Pylatiuk** |

Legend: 💻 Online, 🌐 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Written examination (Duration: 60 min)

**Prerequisites**
This brick may not be taken together with "T-MACH-114910 – Fundamentals of Medical Technology".

**Additional Information**
The course is offered in German.

**Workload**
120 hours

# T 6.101 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 26/27** | **2308480** | Printed and Thin-Film Electronics | **2 SWS** | **Block /** 🗣 | **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 6.102 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 2026** | **2302145** | Process Analysis: Modeling, Data Mining, Machine Learning | **2 SWS** | **Lecture /** 🗣 | **Borchert** |
| **Exams** | | | | | |
| **ST 2026** | **7302145** | Process Analysis: Modeling, Data Mining, Machine Learning | | | **Borchert** |
| **WT 26/27** | **7302145** | Process Analysis: Modeling, Data Mining, Machine Learning | | | **Borchert** |

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Assessment**
Success control takes place in the form of an oral examination lasting approx. 30 minutes.

**Recommendations**
Basics in: Mathematics, differential equations, linear algebra, statistics, basic knowledge of Matlab

# T 6.103 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 26/27** | **2212020** | Process and Plant Design in Biotechnology | **2 SWS** | **Lecture /** 🗣 | **Holtmann** |
| **WT 26/27** | **2212021** | Exercises on 2212020 Process and Plant Design in Biotechnology | **1 SWS** | **Seminar /** 🗣 | **Holtmann** |
| **Exams** | | | | | |
| **WT 26/27** | **7212021-Ü-BioPat** | Process and Plant Design in Biotechnology - 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 6.104 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 26/27** | **2212020** | Process and Plant Design in Biotechnology | **2 SWS** | **Lecture /** 🗣 | **Holtmann** |
| **WT 26/27** | **2212021** | Exercises on 2212020 Process and Plant Design in Biotechnology | **1 SWS** | **Seminar /** 🗣 | **Holtmann** |
| **Exams** | | | | | |
| **ST 2026** | **7212020-V-BioPAT** | Process and Plant Design in Biotechnology | | | **Holtmann** |
| **WT 26/27** | **7212020-V-BioPAT** | Process and Plant Design in Biotechnology | | | **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 6.105 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 2026** | **2231810** | Process and Plant Safety | **2 SWS** | **Lecture /** | **Schmidt** |
| **Exams** | | | | | |
| **ST 2026** | **7231810** | Process and Plant Safety | | | **Schmidt** |
| **WT 26/27** | **7231810** | Process and Plant Safety | | | **Schmidt** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
Learning control is an oral exam lasting approx. 30 minuntes.

**Prerequisites**
None

# T 6.106 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 2026** | **2211010** | Process Engineering for the Production of Food from Animal Origins | **2 SWS** | **Lecture /** | **Gaukel** |
| **Exams** | | | | | |
| **ST 2026** | **7211010** | Process Engineering for the Production of Food from Animal Origins | | | **Gaukel** |
| **ST 2026** | **7211010-2** | Process Engineering for the Production of Food from Animal Origins | | | **Gaukel** |
| **WT 26/27** | **7211010** | Process Engineering for the Production of Food from Animal Origins | | | **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 6.107 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 26/27** | **2211011** | Process Engineering for the Production of Food From Plant-Based Raw Materials | **2 SWS** | **Lecture /** | **van der Schaaf** |
| **Exams** | | | | | |
| **ST 2026** | **7211011** | Process Engineering for the Production of Food from Plant-Based Raw Materials | | | **van der Schaaf** |
| **WT 26/27** | **7211011** | Process Engineering for the Production of Food from Plant-Based Raw Materials | | | **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 6.108 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 26/27** | **2245820** | Process Instruments and Machinery and Their Process Integration | **2 SWS** | **Block / 🗣** | **Nagel** |
| **Exams** | | | | | |
| **WT 26/27** | **7245820** | Process Instruments and Machinery and their Process Integration | | | **Nagel** |

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
None

# T 6.109 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 2026** | **2214110** | Process Modeling in Downstream Processing | **2 SWS** | **Lecture /** | **Franzreb** |
| **Exams** | | | | | |
| **ST 2026** | **7214110** | Process Modeling in Downstream Processing | | | **Franzreb** |
| **WT 26/27** | **7214110** | Process Modeling in Downstream Processing | | | **Franzreb** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**Prerequisites**
None

# T 6.110 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 2026** | **2231210** | Processes and Process Chains for Renewable Resources | **3 SWS** | **Lecture / Practice /** 🗣 | **Dahmen, Sauer** |
| **Exams** | | | | | |
| **ST 2026** | **7231210** | Processes and Process Chains for Renewable Resources | | | **Dahmen, Sauer** |
| **WT 26/27** | **7231210** | Processes and Process Chains for Renewable Resources | | | **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 6.111 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 26/27** | **2245030** | Processing of Nanostructured Particles | **2 SWS** | **Lecture /** 🗣 | **Nirschl** |
| **Exams** | | | | | |
| **ST 2026** | **7245030** | Processing of Nanostructured Particles | | | **Nirschl** |
| **WT 26/27** | **7245030** | Processing of Nanostructured Particles | | | **Nirschl** |

Legend: 🖥 Online, 🌐 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None

# T 6.112 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 26/27** | **2245420** | Production and Development of Cancer Therapeutics | **2 SWS** | **Lecture /** 🗣 | **Leneweit** |
| **Exams** | | | | | |
| **ST 2026** | **7245420** | Production and Development of Cancer Therapeutics | | | **Leneweit** |
| **WT 26/27** | **7245420** | Production and Development of Cancer Therapeutics | | | **Leneweit** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**Prerequisites**
None

# T 6.113 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 | 6 CP | graded | 2 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2220060** | Reactor Modeling with CFD | **1 SWS** | **Lecture /** 🗣 | **Wehinger, Schulz** |
| **ST 2026** | **2220061** | Exercise Reactor Modeling with CFD | **2 SWS** | **Practice /** 🗣 | **Wehinger, und Mitarbeitende, Schulz** |
| **Exams** | | | | | |
| **ST 2026** | **7220060** | Reactor Modeling with CFD | | | **Wehinger** |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None.

# T 6.114 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 2026** | **2231120** | Refinery Technology - Liquid Fuels | **2 SWS** | **Lecture /** | **Rauch** |
| **ST 2026** | **2231121** | Refinery Technology - Exercises | **1 SWS** | **Practice /** | **Rauch, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7231120** | Refinery Technology - Liquid Fuels | | | **Rauch** |
| **WT 26/27** | **7231120** | Refinery Technology - Liquid Fuels | | | **Rauch** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**Prerequisites**
None

# T 6.115 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 6.116 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 2026** | **2242050** | Rheology of Polymers | **2 SWS** | **Lecture /** | **Willenbacher** |
| **Exams** | | | | | |
| **ST 2026** | **7242050** | Rheology of Polymers | | | **Willenbacher** |
| **WT 26/27** | **7242050** | Rheology of Polymers | | | **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 6.117 Module component: Seminar of Food Processing in Practice with Excursion [T-CIWVT-109129]

**Coordinators:** Dr.-Ing. Ulrike van der Schaaf
**Organisation:** KIT Department of Chemical and Process Engineering
**Part of:** M-CIWVT-107679 - Food Processing in Practice

| Type | Credits | Grading | Term offered | Version |
|---|---|---|---|---|
| Oral examination | 2 CP | graded | Each winter term | 3 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **WT 26/27** | **2211930** | Seminar Food Processing in Practice, incl. Excursion | **3 SWS** | **Block /** 🗣 | **Leister, van der Schaaf, Ellwanger, Martin** |
| **Exams** | | | | | |
| **ST 2026** | **7211930** | Seminar of Food Processing in Practice with Excursion | | | **van der Schaaf** |
| **WT 26/27** | **7211930** | Seminar of Food Processing in Practice with Excursion | | | **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 6.118 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 26/27** | **2213030** | Single-Cell Technologies | **2 SWS** | **Lecture /** | **Grünberger** |
| **Exams** | | | | | |
| **ST 2026** | **7213030** | Single-Cell Technologies | | | **Grünberger** |
| **WT 26/27** | **7213030** | Single-Cell Technologies | | | **Grünberger** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

**Assessment**
The learning control is an oral examination.

**Prerequisites**
None

# T 6.119 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 26/27** | **2245230** | Mechanical Separation Technology | **3 SWS** | **Lecture /** | **Gleiß** |
| **WT 26/27** | **2245231** | Exercises for 2245230 Mechanical Separation Technology | **1 SWS** | **Practice /** | **Gleiß** |
| **Exams** | | | | | |
| **ST 2026** | **7245230** | Solid Liquid Separation | | | **Gleiß** |
| **WT 26/27** | **7245230** | Solid Liquid Separation | | | **Gleiß** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

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

**Prerequisites**
None

# T 6.120 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 26/27** | **2242030** | Stability of Disperse Systems | **2 SWS** | **Lecture /** 🗣 | **Willenbacher** |
| **Exams** | | | | | |
| **ST 2026** | **7242030** | Stability of Disperse Systems | | | **Willenbacher** |
| **WT 26/27** | **7242030** | Stability of Disperse Systems | | | **Willenbacher** |

Legend: 💻 Online, 🎲 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

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

**Prerequisites**
None

# T 6.121 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 2026** | **2260150** | Thermal Process Engineering II | **2 SWS** | **Lecture /** 🗣 | **Zeiner** |
| **ST 2026** | **2260151** | Exercises on 2260150 Thermal Process Engineering II | **2 SWS** | **Practice /** 🗣 | **Zeiner, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7260150** | Thermal Process Engineering II | | | **Zeiner** |
| **WT 26/27** | **7260150** | Thermal Process Engineering II | | | **Zeiner** |

Legend: 🖥 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None.

# T 6.122 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 26/27** | **2260120** | Thermal Process Engineering III | **2 SWS** | **Lecture /** 🗣 | **Zeiner** |
| **WT 26/27** | **2260121** | Exercises for 2260120 Thermal Process Engineering III | **2 SWS** | **Practice /** 🗣 | **Zeiner, und Mitarbeitende** |
| **Exams** | | | | | |
| **WT 26/27** | **7260120** | Thermal Process Engineering III | | | **Zeiner** |

Legend: 💻 Online, 🧩 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

# T 6.123 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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2260130** | Thermodynamics for Bioengineering | **2 SWS** | **Lecture /** 🗣 | **Zeiner, Enders** |
| **ST 2026** | **2260131** | Exercises on 2260130 Thermodynamics for Bioengineering | **2 SWS** | **Practice /** 🗣 | **Zeiner, Enders, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7260130** | Thermodynamics for Bioengineering | | | **Enders, Zeiner** |
| **WT 26/27** | **7260130** | Thermodynamics for Bioengineering | | | **Zeiner, Enders** |

Legend: 💻 Online, 🖧 Blended (On-Site/Online), 🗣 On-Site, ✕ Cancelled

**Prerequisites**
None.

**Recommendations**
Thermodynamics II.

# T 6.124 Module component: Water Technology [T-CIWVT-106802]

**Coordinators:** Prof. Dr. Harald Horn
Prof. Dr.-Ing. Marta Markiewicz
**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 26/27** | **2233030** | Water Technology | **2 SWS** | **Lecture /** | **Horn, Markiewicz** |
| **WT 26/27** | **2233031** | Exercises to Water Technology | **1 SWS** | **Practice /** | **Markiewicz, und Mitarbeitende** |
| **Exams** | | | | | |
| **ST 2026** | **7233030** | Water Technology | | | **Horn** |
| **WT 26/27** | **7233030** | Water Technology | | | **Horn** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled

# T 6.125 Module component: Water Technology [T-CIWVT-114614]

**Coordinators:** Prof. Dr.-Ing. Marta Markiewicz
**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 |

| Courses | | | | | |
|---|---|---|---|---|---|
| **ST 2026** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dahmen, Franzreb, Grünberger, Holtmann, Horn, Hubbuch, van der Schaaf** |
| **WT 26/27** | **2200320** | Research Internship Master BIW | **6 SWS** | **Practical course /** 🗣 | **Dozierende der KIT-Fakultät** |
| **Exams** | | | | | |
| **ST 2026** | **7200326** | Water Technology - Research Internship Master BIW | | | **Horn** |
| **WT 26/27** | **7200326** | Water Technology - Research Internship Master BIW | | | **Horn** |

Legend: Online, Blended (On-Site/Online), On-Site, × Cancelled