# Experimente in der Strömungsmechanik (Experimental Fluid Mechanics)

**Relevance for ResEngin curriculum**: compulsory elective

**Administration**
- Inst. f. Hydromechanik
- cornelia.lang@kit.edu

**Term(s) offered**: 3rd term (Winter Oct-Mar)

**Duration | Cycle**: 1 term; every other year

**Language of instruction**: German

**Prerequisites**: Bachelor, German language proficiency at DSH level

**Module coordinator**: LANG, Dr.-Ing. Cornelia; IfH [Modulverantwortliche]

**Learning outcomes**: Description see p. 2.

**Literature / Course materials**: Reference list see p. 3.

**Basis for module(s)**: not applicable

**Intersection with module(s)**: M 1 Hydraulic & Environmental Engineering
- M 7 Integrated Projects

### Lecture courses

**Lecture courses** (training mode)
- 19231 Experimente in d. Strömungsmechanik (lecture, excursion, labcourse) 5.0 CP 1+3 WCH

**Workload specification**

(30 work hours → 1 CP acc. to ECTS) 5 x 30 h 150 h

**Lecture Phase**:  
- Contact hours 10.5 h  
- Self instruction 14.0 h  
- Lab work 31.5 h  
- Exam preparation 63.0 h

**Exam Phase**:  
- Self instruction 30.0 h

**Module examination(s)**

<table>
<thead>
<tr>
<th>(mode</th>
<th>scope</th>
<th>weighting)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Strömungsmechanik” oral</td>
<td>30 min</td>
<td>5.0/5.0 CP</td>
</tr>
</tbody>
</table>

**Lecturers** (in alphabetic order)
- LANG, Dr.-Ing. Cornelia; IfH

**Individual lecture courses**

Descriptions + Recommended background knowledge see p. 4.
Module T1a: “Experimental Fluid Mechanics” (cont.)

Module topic

Application of experimental fluid mechanics.

Learning outcomes

Disciplinary knowledge

- **concepts, theories & definitions**
  similitude: requirements, dimensionless fluid parameters, scaling laws; modelling hydraulic problems: dimensional analysis, scale effects, design of hydraulic models, examples.

- **subject matter (factual data, examples)**
  pipe flow with orifice plate: pressure distribution, jet shape and contraction; open channel flow with vertical gate and hydraulic jump: measurement of pressure and water levels; venturi pipe flow with cavitation: pressure distribution; settling velocities of spheres: resistance in different fluids; diffusion of a turbulent air jet: transport of mass, energy and momentum.

- **methods & procedures**
  typical setup of hydraulic/aerodynamic models, measurement instrumentation.

Professional skills

- Capability of working with physical models and to interpret their results.
- Preparation of test reports. Presenting of results.

Personal competence

- Collaborative work on engineering project (physical model application).
Module T1a: “Experimental Fluid Mechanics” (cont.)

Literature/ Course material


Lecture notes
- “Experimente in der Strömungsmechanik”
Module T1a

Course

Experimente in der Strömungsmechanik
(Experimental Fluid Mechanics)

Experimente in der Strömungsmechanik:
Modelluntersuchungen
(Experimental Fluid Mechanics: Physical Model Analysis)

<table>
<thead>
<tr>
<th>KIT lecture ID</th>
<th>19231</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevance</td>
<td>compulsory elective</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>Bachelor, German proficiency (DSH level)</td>
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<tr>
<td>Term(s)</td>
<td>3rd term (winter)</td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
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<tr>
<td>Training mode</td>
<td>Lecture, 1 WCH *, Labcourse, 3 WCH</td>
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<tr>
<td>Workload</td>
<td>5.0 CP (\Rightarrow) 150.0 h</td>
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<table>
<thead>
<tr>
<th>Workload specification</th>
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<tbody>
<tr>
<td><strong>LECTURE PHASE</strong></td>
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<tr>
<td>Contact (based on 1 WCH)</td>
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<tr>
<td>Self Instruction</td>
</tr>
<tr>
<td>Lab work</td>
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<tr>
<td>Exam preparation</td>
</tr>
<tr>
<td><strong>EXAM PHASE</strong></td>
</tr>
<tr>
<td>Self-instruction</td>
</tr>
</tbody>
</table>

Contact: cornelia.lang@kit.edu

Lecturer(s)
LANG, Dr.-Ing. Cornelia; IfH

Course topic
Complex flow situations and the application of experimental fluid mechanics.

Recommended background knowledge
Fundamentals of Hydromechanics

Learning outcomes

Disciplinary knowledge
- concepts, theories & definitions
  similitude: requirements, dimensionless fluid parameters, scaling laws; modelling hydraulic problems: dimensional analysis, scale effects, design of hydraulic models, examples.
- subject matter (factual data, examples)
  pipe flow with orifice plate: pressure distribution, jet shape and contraction; open channel flow with vertical gate and hydraulic jump: measurement of pressure and water levels; venturi pipe flow with cavitation: pressure distribution; settling velocities of spheres: resistance in different fluids; diffusion of a turbulent air jet: transport of mass, energy and momentum.
- methods & procedures
  typical setup of hydraulic/aerodynamic models, measurement instrumentation

Professional skills
Capability of working with physical models and to interpret their results. Preparation of test reports. Presenting of results.

Personal competence
Collaborative work on engineering project (physical model application).

Assessment specification
written ---
oral 30 min = module exam “Strömungsmechanik”
other ---

* WCH = Weekly Contact Hours
# Energiewasserbau (Hydropower Engineering)  
**RESE M T1b**

<table>
<thead>
<tr>
<th>Relevance for ResEngin curriculum</th>
<th>compulsory elective</th>
<th><strong>Administration</strong></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Inst. f. Wasser &amp; Gew. enw.</td>
<td><a href="mailto:peter.oberle@kit.edu">peter.oberle@kit.edu</a></td>
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<table>
<thead>
<tr>
<th>Term(s) offered</th>
<th>2nd (Summer Apr–Sept)</th>
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<tbody>
<tr>
<td>Duration</td>
<td>1 term; every year</td>
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<td>Prerequisites</td>
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<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>OBERLE, Dr.-Ing. Peter; IWG-WK [Modulverantwortlicher]</th>
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<tbody>
<tr>
<td>Learning outcomes</td>
<td>Description see p. 2.</td>
</tr>
<tr>
<td>Literature / Course materials</td>
<td>Reference list see p. 3.</td>
</tr>
</tbody>
</table>

**Basis for module(s)**  
not applicable

**Intersection with module(s)**  
M 1 Hydraulic & Environmental Engineering

**Lecture courses**  
(training mode)  
19208 Energiewasserbau  
(lecture)  
SUM 5.0 CP 4 WCH

| Workload specification | (30 work hours → 1 CP acc. to ECTS)  
5 x 30 h 150 h |
|------------------------|--------------------------------------------------|
| Lecture Phase: | Contact hours 42.0 h  
Self instruction 63.0 h |
| Exam Phase: | Self instruction 45.0 h |

**Module examination(s)**  
(training mode | scope | weighting)  
“Energiewasserbau” written | 75 min | 5.0/5.0 CP

<table>
<thead>
<tr>
<th>Lecturers</th>
<th>OBERLE, Dr.-Ing. Peter; IWG-WK</th>
</tr>
</thead>
</table>

| Individual lecture courses | Descriptions + Recommended background knowledge | see p. 4. |
Module T1b: “Hydropower Engineering” (cont.)

Module topic

The current political and legal framework as major context factor for practice-oriented planning, operation and maintenance of hydropower plants considering environmental issues.

Learning outcomes

Disciplinary knowledge

- concepts, theories & definitions
  turbines (e.g. Euler’s turbine equation); flow conditions in turbines; mass oscillation and water hammer phenomena; analysis of water power capacity; essentials for creating a plan of water-economic capability; electro-technical basics of power generation.

- subject matter (factual data, examples)
  constructional characteristics of river and high-pressure power plants; operating modes and selection criteria of different types of turbines as well as electro-technical aspects of the plants’ operation; consideration of ecological aspects and energy policy; presentation of current projects and excursions.

- methods & procedures
  technical background for planning and designing hydropower plants.

Professional skills

- Gain expertise in planning hydropower plants considering turbine pre-selection, structural dimensions (e.g. powerhouse, draft tube), and economic aspects.

Personal competence

- n.a.
Module T1b: “Hydropower Engineering” (cont.)

Literature/ Course material


Lecture notes

– “Energiewasserbau”
**Module T1b**

**Course**

**Energiewasserbau**  
(Hydropower Engineering)

### KIT lecture ID
19208

### Workload specification

<table>
<thead>
<tr>
<th><strong>LECTURE PHASE</strong></th>
<th>42.0 h</th>
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<tbody>
<tr>
<td>Contact (based on 4 WCH)</td>
<td>Self Instruction</td>
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<tr>
<td>63.0 h</td>
<td></td>
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<tr>
<td><strong>EXAM PHASE</strong></td>
<td>45.0 h</td>
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<tr>
<td>Self-instruction</td>
<td></td>
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</table>

### Contact
peter.oberle@kit.edu

### Lecture, 4 WCH *
5.0 CP 150.0 h

<table>
<thead>
<tr>
<th><strong>LECTURE PHASE</strong></th>
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<td>Self Instruction</td>
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<tr>
<td>63.0 h</td>
<td></td>
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<tr>
<td><strong>EXAM PHASE</strong></td>
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<td>Self-instruction</td>
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<table>
<thead>
<tr>
<th>Lecturer(s)</th>
<th>OBERLE, Dr.-Ing. Peter; IWG-WK</th>
</tr>
</thead>
</table>

### Course topic
Current political and legal framework as major context factor for practice-oriented planning, operation and maintenance of hydropower plants considering environmental issues.

### Learning outcomes

#### Disciplinary knowledge
- **concepts, theories & definitions**
  - turbines (e.g. Euler's turbine equation); flow conditions in turbines; mass oscillation and water hammer phenomena; analysis of water power capacity; essentials for creating a plan of water-economic capability; electro-technical basics of power generation.
- **subject matter (factual data, examples)**
  - constructional characteristics of river and high-pressure power plants; operating modes and selection criteria of different types of turbines as well as electro-technical aspects of the plants' operation; consideration of ecological aspects and energy policy; presentation of current projects and excursions.
- **methods & procedures**
  - technical background for planning and designing hydropower plants

#### Professional skills
- Gain expertise in planning hydropower plants considering turbine pre-selection, structural dimensions (e.g. powerhouse, draft tube), and economic aspects.

#### Personal competence
n.a.

### Assessment specification
- written 75 min = module exam “Energiewasserbau”
- oral ---
- other ---

* WCH = Weekly Contact Hours
# Numerical Water Management Planning Tools

<table>
<thead>
<tr>
<th>Relevance for ResEngin curriculum</th>
<th>compulsory elective</th>
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<tr>
<td></td>
<td></td>
<td>ResEngin Office</td>
<td><a href="mailto:res.eng@kit.edu">res.eng@kit.edu</a></td>
</tr>
</tbody>
</table>

## Term(s) offered
- 3rd (Winter Oct–Mar)

## Duration | Cycle
- 1 term; every year

## Language of instruction
- German / English

## Prerequisites
- Bachelor, German language proficiency at DSH level

## Module coordinator
- MOHRLOK, PD Dr.rer.nat. Ulf; IfH [Modulverantwortlicher]

## Learning outcomes
- Description see p. 2.

## Literature / Course materials
- Reference list see p. 3.

## Basis for module(s)
- not applicable

## Intersection with module(s)
- M 1 Hydraulic & Environmental Engineering
- M 3 Geoinformatics
- M 4 Soil & Groundwater Resources

## Lecture courses

<table>
<thead>
<tr>
<th>(training mode)</th>
<th>xxxx</th>
<th>Analyse &amp; Plang. v Wasservert.netzen (seminar)</th>
<th>3.0 CP</th>
<th>2 WCH</th>
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<tbody>
<tr>
<td>xxxx</td>
<td>Groundwater Modeling (seminar)</td>
<td>2.0 CP</td>
<td>1 WCH</td>
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**SUM** 5.0 CP 2 WCH

## Workload specification

<table>
<thead>
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<th>(30 work hours → 1 CP acc. to ECTS)</th>
<th>5 x 30 h</th>
<th>150 h</th>
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<tbody>
<tr>
<td>Lecture Phase:</td>
<td>Contact hours 31.5 h</td>
<td>Self instruction 43.5 h</td>
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</tbody>
</table>

Examination:
- Self instruction 40.0 h

## Module examination(s)

- "Wasserverteilungsnetze” report+pres. | 2.000 w.+20 min | 3/5 CP
- "Groundwater Modeling” report+pres. | 1.5-1.700 w.+15 min | 2/5 CP

## Lecturers

- KLINGEL, Dr.-Ing. Philipp; IWG-WK
- MOHRLOK, PD Dr.rer.nat. Ulf; IfH

## Individual lecture courses

- Descriptions + Recommended background knowledge see pp. 4.
Module T1c: “Numerical Water Management Planning Tools” (cont.)

Module topic

Water distribution and network design; application of network models for analysis and design; mathematical principles and schematization concept of hydraulic network models; approximation of numerical models, accuracy and reliability of numerical results.

Learning outcomes

Disciplinary knowledge

- concepts, theories & definitions

- subject matter (factual data, examples)
  Exercises, case studies, project work. Groundwater flow and transport model application for a specified problem, discussion of numerical results regarding accuracy and reliability.

- methods & procedures
  Planning & Design: Best practice in water distribution. Software application: Simulation software EPANET and geo information system ArcGIS. Project work: Modelling of an example network, deficiency analysis of the modelled network and planning and design of a network extension. Transfer problem into numerical model.

Professional skills

- To gain expertise in the methodology of deficiency analysis, software application and presentation of results within the context of water distribution.

- To gain expertise in numerical model application and critical review of numerical results.

Personal competence

- Team work, project planning, solution development, problem solving.
Module T1c: “Numerical Water Management Planning Tools” (cont.)

**Literature/ Course material**


Module T1c

Numerical Water Management Planning Tools

Course

Analyse & Planung von Wasserverteilungsnetzen
(Water Supply Network Planning)

<table>
<thead>
<tr>
<th>KIT lecture ID</th>
<th>Workload specification</th>
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</thead>
<tbody>
<tr>
<td>xxxxx</td>
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<td>Relevance</td>
<td>compulsory elective</td>
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<td>Term(s)</td>
<td>3rd term (winter)</td>
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<td>Language</td>
<td>German</td>
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<tr>
<td>Training mode</td>
<td>Seminar, 2 WCH *</td>
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<tr>
<td>Workload</td>
<td>3.0 CP ⇒ 90.0 h</td>
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**Lecture Phase**
- Contact (based on 2 WCH) 21.0 h
- Self Instruction 14.0 h
- Team Work 35.0 h

**Exam Phase**
- Group report 20.0 h

**Contact**
philipp.klingel@kit.edu

**Lecturer(s)**
KLINGEL, Dr.-Ing. Philipp; IWG-WK

**Course topic**
(a) Water distribution and network design, (b) the mathematical principles and the schematisation concept of hydraulic network models and (c) the application of network models for analysis and design.

**Recommended background knowledge**
Fundamentals of hydraulics

**Learning outcomes**

- **Disciplinary knowledge**
  - concepts, theories & definitions
    - conceptual approach of water distribution networks modelling, graph theory, mathematical equations describing the hydraulic steady state of water distribution networks, water balance, criteria for water distribution network design.
  - subject matter (factual data, examples)
    - exercises, case studies, project work.
  - methods & procedures
    - planning & Design: Best practice in water distribution. Software application: Simulation software EPANET and geo information system ArcGIS. Project work: Modelling of an example network, deficiency analysis of the modelled network and planning and design of a network extension.

- **Professional skills**
  - To gain expertise in the methodology of deficiency analysis, software application and presentation of results within the context of water distribution.

- **Personal competence**
  - Team work, project planning, solution development, problem solving.

**Assessment specification**
- written ---
- oral ---
- other report + pres. = partial module exam "Wasserverteilungsnetze" (2.000 words + 20 min)

* WCH = Weekly Contact Hours
### Course

**Groundwater Modeling**

<table>
<thead>
<tr>
<th>KIT lecture ID</th>
<th>xxxx</th>
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<tr>
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<td>compulsory elective</td>
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<td><strong>Prerequisites</strong></td>
<td>Bachelor, German proficiency (DSH level)</td>
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<tr>
<td><strong>Term(s)</strong></td>
<td>3rd term (winter)</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>English</td>
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<tr>
<td><strong>Training mode</strong></td>
<td>Lecture, 1 WCH</td>
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<tr>
<td><strong>Workload</strong></td>
<td>2.0 CP $\Rightarrow$ 60.0 h</td>
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<tr>
<th><strong>Workload specification</strong></th>
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<tbody>
<tr>
<td><strong>LECTURE PHASE</strong></td>
</tr>
<tr>
<td>Contact (based on 1 WCH)</td>
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<tr>
<td>Self Instruction</td>
</tr>
<tr>
<td><strong>EXAM PHASE</strong></td>
</tr>
<tr>
<td>Report</td>
</tr>
</tbody>
</table>

**Contact**

ulf.mohrlok@kit.edu

**Lecturer(s)**

Mohrlok, PD Dr. rer. nat. Ulf; IfH

**Course topic**

Approximate nature of numerical models, accuracy and reliability of numerical results.

**Recommended background knowledge**

Fundamentals of Groundwater Flow and Transport

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  - principles of numerical modelling.
- **subject matter (factual data, examples)**
  - groundwater flow and transport model application for a specified problem, discussion of numerical results regarding accuracy and reliability.
- **methods & procedures**
  - transfer problem into numerical model.

**Professional skills**

To gain expertise in numerical model application and critical review of numerical results.

**Personal competence**

n.a.

**Assessment specification**

- written ---
- oral ---
- other report + pres. = partial module exam “Groundwater Modeling”
  (1.5–1.700 words + 15 min)

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* WCH = Weekly Contact Hours
Numerische Modelle im Wasserbau
(Numerical Models in Hydraulic Engineering)

**Relevance**

compulsory elective

**Administration**

Inst. f. Wasser & Gew. entw.
Wasserwirtschaft & Kulturtech.

**Contact**

peter.oberle@kit.edu

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**Term(s) offered**

3rd (Winter Oct.-Mar)

**Duration **

1 term; every year

**Language of instruction**

German

**Prerequisites**

Bachelor, German language proficiency at DSH level

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**Module coordinator**

OBERLE, Dr.-Ing. Peter; IWG-WK

[Modulverantwortlicher]

**Learning outcomes**

Description see p. 2.

**Literature / Course materials**

Reference list see p. 3.

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**Basis for module(s)**

not applicable

**Intersection with module(s)**

M 1 Hydraulic & Environmental Engineering
MT1c Numerical Water Management Planning Tools

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**Lecture courses**

(Training mode)

19208 Numerische Modelle im Wasserbau
(lecture, labcourse)

5.0 CP 2+1 WCH

**SUM** 5.0 CP 3 WCH

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**Workload specification**

(30 work hours → 1 CP acc. to ECTS) 5 x 30 h 150 h

**Lecture Phase:**

Contact hours 21.0 h
Self instruction 42.0 h
Lab work 10.5 h
Exam preparation 31.5 h

**Exam Phase:**

Self instruction 45.0 h

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**Module examination(s)**

(mode | scope | weighting)

"Numerische Modelle" oral | 20 min | 5.0/5.0 CP

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**Lecturers**

(in alphabetic order)

- OBERLE, Dr.-Ing. Peter; IWG-WK

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**Individual lecture courses**

Descriptions + Recommended background knowledge see p. 4.
Module T1d: “Numerical Models in Hydraulic Engineering” (cont.)

<table>
<thead>
<tr>
<th>Module topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice of appropriate modeling techniques and assessment of uncertainties in hydraulic simulations for regional and local planning projects as well as interpretation of computation results.</td>
</tr>
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<table>
<thead>
<tr>
<th>Learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disciplinary knowledge</strong></td>
</tr>
<tr>
<td>- <strong>concepts, theories &amp; definitions</strong></td>
</tr>
<tr>
<td>physical equations and numeric solution procedures.</td>
</tr>
<tr>
<td>- <strong>subject matter (factual data, examples)</strong></td>
</tr>
<tr>
<td>base data (topography, hydrologic boundary conditions); modeling techniques and calibration; hydraulic evaluation of measures in the river valley; automated operation of barrages in rivers.</td>
</tr>
<tr>
<td>- <strong>methods &amp; procedures</strong></td>
</tr>
<tr>
<td>data preparation and visualization by the use of GIS technology (pre- and post-processing).</td>
</tr>
<tr>
<td><strong>Professional skills</strong></td>
</tr>
<tr>
<td>- Application of one- and multi-dimensional hydrodynamic numeric river-flow models.</td>
</tr>
<tr>
<td><strong>Personal competence</strong></td>
</tr>
<tr>
<td>- Work on small projects in a team.</td>
</tr>
</tbody>
</table>
Module T1d: “Numerical Models in Hydraulic Engineering” (cont.)

Literature/ Course material


Malcherek, A. (2001). *Hydromechanik der Fließgewässer*. Bericht Nr. 61, Institut für Strömungsmechanik und Elektronisches Rechnen im Bauwesen der Universität Hannover, Universität Hannover, 382 S.

Lecture notes

– “Numerische Modelle im Wasserbau”
**Module T1d**

**Course**

**Numerische Modelle im Wasserbau**
(Numerical Models in Hydraulic Engineering)

<table>
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<td>Term(s)</td>
<td>3rd term (winter)</td>
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<td>Language</td>
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<td>Training mode</td>
<td>Lecture, 2 WCH * Labcourse, 1 WCH</td>
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<td>Workload</td>
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<td>Contact (based on 2 WCH)</td>
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<td>Self instruction</td>
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<tr>
<td>Lab work</td>
</tr>
<tr>
<td>Exam preparation</td>
</tr>
<tr>
<td><strong>EXAM PHASE</strong></td>
</tr>
<tr>
<td>Self-instruction</td>
</tr>
</tbody>
</table>

| **Contact** |
| mark.musall@kit.edu |

**Lecturer(s)**

OBERLE, Dr.-Ing. Peter; IWG-WK

**Course topic**

Choice of appropriate modeling techniques; assessment of uncertainties in hydraulic simulations for regional and local planning projects and interpretation of computation results.

Recommended background knowledge

- Fundamentals of engineering physics, mathematics and hydromechanics

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  - physical equations and numeric solution procedures.
- **subject matter (factual data, examples)**
  - base data (topography, hydrologic boundary conditions); modeling techniques and calibration; hydraulic evaluation of measures in the river valley; automated operation of barrages in rivers.
- **methods & procedures**
  - data preparation and visualization by the use of GIS technology (pre- and post-processing).

**Professional skills**

Application of one- and multi-dimensional hydrodynamic numeric river-flow models.

**Personal competence**

Work on small projects in a team.

**Assessment specification**

written ---
oral 20 min = module exam "Numerische Modelle"
other ---

---

* WCH = Weekly Contact Hours
# Umweltbiotechnologische Verfahren (Air, Water & Soil Purification Processes)  
**RESE M T2a**

## Relevance for ResEngin curriculum
- Compulsory elective

## Administration
- Inst. f. Ing. biologie & Biotechn. d. Abwassers
- josef.winter@kit.edu

## Contact
- Inst. f. Ing. biologie & Biotechn. d. Abwassers

## Term(s) offered
- 2nd (Summer Apr–Sept)

## Duration | Cycle
- 1 term; every year

## Language of instruction
- German

## Prerequisites
- Bachelor, German language proficiency at DSH level

## Module coordinator
- WINTER, Dr.rer.nat. habil. Josef, Ord.; IBA [Modulverantwortlicher]

## Learning outcomes
- Description see p. 2.

## Literature / Course materials
- Reference list see p. 3.

## Basis for module(s)
- Not applicable

## Intersection with module(s)
- M 2 Waste & Waste Water Technologies

### Lecture courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Lecture</th>
<th>Duration</th>
<th>WCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>19251</td>
<td>Abluftreinigung (lecture)</td>
<td>1.5 CP</td>
<td>1 WCH</td>
</tr>
<tr>
<td>19xxx</td>
<td>Bodensanierung (lecture)</td>
<td>1.5 CP</td>
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<td>19244</td>
<td>Industrieabwasserreinigung (lecture)</td>
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## Workload specification

- 5 x 30 h = 150 h

### Lecture Phase:
- Contact hours: 42.0 h
- Self instruction: 63.0 h

### Exam Phase:
- Self instruction: 45.0 h

## Module examination(s)

- "Abluftreinigung"
  - Oral: 15 min | 1.5/5.0 CP
- "Bodensanierung"
  - Oral: 15 min | 1.5/5.0 CP
- "Industrieabwasserreinigung"
  - Oral: 30 min | 2.0/5.0 CP

## Lecturers

- GALLERT, PD Dr.rer.nat. Claudia; IBA
- WINTER, Dr.rer.nat. habil. Josef, Ord.; IBA

## Individual lecture courses

- Descriptions + Recommended background knowledge see pp. 4.
Module T2a: “Air, Water & Soil Purification Processes” (cont.)

Module topic

An appropriate choice of (a) off-gas purification processes for specific types of pollution and industry; (b) remediation processes and a choice of suitable processes for specific types of pollution. Problems of industrial wastewater treatment.

Learning outcomes

Disciplinary knowledge
- concepts, theories & definitions
  Off-gas characterization and measurement, legal aspects, different treatment options and examples from different industries. Characterization of the main pollutants (PAK, BTEX, hydrocarbons, pesticides, heavy metals), soil characteristics and treatment options for different types of contaminated soils. Differences between domestic and industrial wastewater treatment, characterization of wastewater from food and paper industries, process concepts for industrial wastewater purification.
- subject matter (factual data, examples)
  Established methods for cleaning waste air or off-gas from different fields using physical/thermal, chemical or biological processes. Established methods to remediate polluted soil in-situ or ex-situ with thermal, physical-chemical or biological processes according to the legal requirements. Modern reactors for industrial wastewater purification.
- methods & procedures
  Technically applied methods and processes to purify air with filters, washers, etc. Incineration, soil washing/extraction, land farming, reactor technologies, natural attenuation, phytoremediation. UASB/EGSB reactors, anaerobic filters, fixed-bed reactors and applicability for different types of wastewaters, problems and solutions.

Professional skills
- Understanding of the different processes and decision making.
- Planning remediation processes.
- To define process solutions for different industries. To learn how to proceed with basic engineering to design an industrial plant.

Personal competence
- Critical evaluation of process applicability and treatment costs
- Knowledge of technologies to improve environmental quality
Module T2a: “Air, Water & Soil Purification Processes” (cont.)

Literature/ Course material


Lecture notes

- “Abluftreinigung”
- “Bodensanierung”
- “Industrieabwasserreinigung”
### Module T2a

Umweltbiotechnologische Verfahren  
(Air, Water & Soil Purification Processes)

### Course

**Abluftreinigung**  
(Off-Gas Purification)

<table>
<thead>
<tr>
<th>KIT lecture ID</th>
<th>Workload specification</th>
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**Relevance**: compulsory elective  
**Prerequisites**: Bachelor, German proficiency (DSH level)  
**Term(s)**: 2nd term (summer)  
**Language**: German  
**Training mode**: Lecture, 1 WCH  
**Workload**: 1.5 CP ⇒ 45.0 h  

### Workload specification

**LECTURE PHASE**  
- **Contact** (based on 1 WCH)  
  - 10.5 h  
  - Self instruction  
  - 21.0 h

**EXAM PHASE**  
- **Self-instruction**  
  - 13.5 h

**Contact**

claudia.gallert@kit.edu

### Lecturer(s)

GALLERT, PD Dr.rer.nat. Claudia; IBA

### Course topic

Appropriate choice of an off-gas purification process for a specific type of pollution and industry.

**Recommended background knowledge**  
Fundamentals of biology, chemistry, process engineering.

### Learning outcomes

**Disciplinary knowledge**
- **concepts, theories & definitions**  
  off-gas characterization and measurement, legal aspects, different treatment options and examples from different industries.
- **subject matter (factual data, examples)**  
  established methods for cleaning waste air or off-gas from different fields using physical/thermal, chemical or biological processes.
- **methods & procedures**  
  technically applied methods and processes to purify air with filters, washers, etc.

**Professional skills**
Understanding of the different processes and decision making.

**Personal competence**
Critical evaluation of process applicability.

**Assessment specification**

- written ---
- oral 15 min = partial module exam “Abluftreinigung”  
- other ---

* WCH = Weekly Contact Hours
Module T2a

Umweltbiotechnologische Verfahren
(Air, Water & Soil Purification Processes)

Course

Bodensanierung
(Soil Remediation)

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**Workload specification**

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**Exam Phase**

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</tbody>
</table>

**Contact**

claudia.gallert@kit.edu

**Lecturer(s)**

GALLERT, PD Dr.rer.nat. Claudia; IBA

**Course topic**

Remediation processes and a choice of a suitable process for a specific type of pollution.

**Recommended background knowledge**

Fundamentals of biology, chemistry, process engineering and ecology

**Disciplinary knowledge**

- **concepts, theories & definitions**
  - characterization of the main pollutants (PAK, BTEX, hydrocarbons, pesticides, heavy metals), soil characteristics and treatment options for different types of contaminated soils.

- **subject matter (factual data, examples)**
  - established methods to remediate polluted soil in-situ or ex-situ with thermal, physico-chemical or biological processes according to the legal requirements.

- **methods & procedures**
  - incineration, soil washing/extraction, land farming, reactor technologies, natural attenuation, phytoremediation.

**Professional skills**

Planning remediation processes.

**Personal competence**

Critical evaluation of process applicability and treatment costs.

**Assessment specification**

written ---
oral 15 min = partial module exam “Bodensanierung”
other ---

\* WCH = Weekly Contact Hours
Module T2a

Umweltbiotechnologische Verfahren
(Air, Water & Soil Purification Processes)

Course

Industrieabwasserreinigung
(Treatment of Industrial Wastewater)

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**Workload specification**

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**Contact**

josef.winter@kit.edu

**Lecturer(s)**

WINTER, Dr.rer.nat. habil. Josef, Ord.; IBA

**Course topic**

Problems of industrial wastewater treatment; relevant for various branches of industry such as milk-/cheese industry, starch, cellulose or paper industry.

**Recommended background knowledge**

- Fundamentals of biology, inorganic and organic chemistry and process engineering

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  Differences between domestic and industrial wastewater treatment, characterization of wastewater from food and paper industries, process concepts for industrial wastewater purification.
- **subject matter (factual data, examples)**
  modern reactors for industrial wastewater purification.
- **methods & procedures**
  UASB/EGSB reactors, anaerobic filters, fixed-bed reactors and applicability for different types of wastewaters, problems and solutions.

**Professional skills**

To define process solutions for different industries. To learn how to proceed with basic engineering to design an industrial plant.

**Personal competence**

Knowledge of technologies to improve environmental quality.

**Assessment specification**

written ---
oral 30 min = partial module exam "Industrieabwasserreinigung"
other ---

* WCH = Weekly Contact Hours
Stoffumsatz und Transport im Untergrund
(Sub-surface Transport and Transformation)  
RESE M T2b

Relevance
for ResEngin curriculum

compulsory elective

Administration
Inst. f. Hydromechanik; ulf.mohrlrok@kit.edu
Institut für Mineralogie

Contact

Term(s) offered
2nd (Summer Apr–Sept) + 3rd (Winter Oct–Mar)

Duration | Cycle
2 terms; every year

Language of instruction
German

Prerequisites
Bachelor, German language proficiency at DSH level

Module coordinator
MOHRLOK, PD Dr.rer.nat. Ulf; IfH  [Modulverantwortlicher]

Learning outcomes
Description see p. 2.

Literature / Course materials
Reference list see p. 3.

Basis for module(s)
not applicable

Intersection with module(s)
not applicable

M 4  Soil and Groundwater Resources

Lecture courses
(training mode)
19xxx Geochemische Stoffkreisläufe (lecture)  2.5 CP  2 WCH
19xxx Stofftransport im Untergrund (lecture)  2.5 CP  2 WCH

SUM  5.0 CP  4 WCH

Workload specification
(30 work hours → 1 CP acc. to ECTS)  5 x 30 h  150 h

Lecture Phase: Contact hours
42 h
Self instruction hours
63 h

Exam Phase:
Self instruction hours
45 h

Module examination(s)
(mode | scope | weighting)
“Stoffumsatz & Transporte im Untergrund”  oral | 30 min | 5.0/5.0 CP

Lecturers
(in alphabetic order)
− MOHRLOK, PD Dr.rer.nat. Ulf; IfH
− NEUMANN, Dr.rer.nat. Thomas, apl. Prof.; IMG
− NORRA PD Dr.rer.nat Stefan; IfGG

Individual lecture courses
Descriptions + Recommended background knowledge  see pp. 4.
Module T2b: “Sub-surface Transport & Transformation” (cont.)

Module topic
The environmental impact of mineral/water interaction processes controlling the natural cycling of elements and providing technical solutions for the remediation of degraded water resources. Transport processes in the heterogeneous subsurface environment; reliability and uncertainty in measured data, simplification of model approaches.

Learning outcomes

Disciplinary knowledge

- concepts, theories & definitions
  - Mineral/water interactions affecting the quality of water resources and important earth processes, such as weathering, diagenesis and environmental processes. Principles of mass transport in porous media, transport processes.

- subject matter (factual data, examples)
  - Mineralogy and geochemistry of sediments (limestone, sandstone, mudstone, pyroclastics, evaporites, organic deposits), rock weathering and diagenesis; transport and deposition of elements; cycles of contaminants, such as arsenic; degradation of water resources (e.g. eutrophication) and remediation measures; fate of metals in estuarine systems, fossil energy resources.
  - Transport in heterogeneous sub-surface, solute transport, colloid transport, multiphase flow and transport, feedback mechanisms, groundwater remediation.

- methods & procedures
  - Methods and facilities in rock and water analytics, data evaluation in geochemistry; environmental assessment of analytical data. Mass balances, modelling approaches.

Professional skills

- Valuation of the relevance of mineralogy for general environmental processes.
- To gain expertise in groundwater quality development through understanding of basic processes and application of simple modelling approaches.

Personal competence

- Ability to participate in discussions on environmental problems from an mineralogical and geochemical point of view.
Module T2b: “Sub-surface Transport & Transformation” (cont.)

Literature/ Course material


Module T2b

Stoffumsatz und Transport im Untergrund
(Sub-surface Transport & Transformations)

Course

Geochemische Stoffkreisläufe
(Geochimical Cycling of Elements)

| KIT lecture ID | xxxx
|----------------|------
| Relevance      | compulsory elective
| Prerequisites  | Bachelor, German proficiency (DSH level)
| Term(s)        | 2nd term (summer)
| Language       | German
| Training mode  | Lecture, 2 WCH
| Workload       | 2.5 CP \(\Rightarrow\) 75.0 h

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<tr>
<td><strong>EXAM PHASE</strong></td>
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<td>Self-instruction</td>
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Contact

thomas.neumann@kit.edu
stefan.norra@kit.edu

Lecturer(s)

NEUMANN, Dr.rer.nat. Thomas, apl. Prof.; IMG
NORRA PD Dr.rer.nat Stefan; IfGG

Course topic

Environmental impact of mineral/water interaction processes controlling the natural cycling of elements and providing technical solutions for the remediation of degraded water resources. Relevant case studies, especially from developing countries, will be discussed. Improved knowledge on sedimentary systems and related water resources.

Recommended background knowledge

Fundamentals of chemistry

Learning outcomes

Disciplinary knowledge

- concepts, theories & definitions
  mineral/water interactions affecting the quality of water resources and important earth processes, such as weathering, diagenesis and environmental processes.

- subject matter (factual data, examples)
  mineralogy and geochemistry of sediments (limestone, sandstone, mudstone, pyroclastics, evaporites, organic deposits), rock weathering and diagenesis; transport and deposition of elements; cycles of contaminants, such as arsenic; degradation of water resources (e.g. eutrophication) and remediation measures; fate of metals in estuarine systems, fossil energy resources.

- methods & procedures
  methods and facilities in rock and water analytics, data evaluation in geochemistry; environmental assessment of analytical data.

Professional skills

Valuation of the relevance of mineralogy for general environmental processes.

Personal competence

Ability to participate in discussions on environmental problems from an mineralogical and geochemical point of view.

Assessment specification

written ---
oral 30 min = module exam "Stoffumsatz und Transport im Untergrund" together with LV Stofftransport im Untergrund
other ---

* WCH = Weekly Contact Hours
# Course

**Module T2b**

| **Course** | **Stofftransport im Untergrund**  
(Sub-surface Mass Transport) |
| --- | --- |

| **Module ID** | 19xxx |
| **Relevance** | compulsory elective |
| **Prerequisites** | Bachelor, German proficiency (DSH level) |
| **Term(s)** | 3rd term (winter) |
| **Language** | German |
| **Training mode** | Lecture, 2 WCH |
| **Workload** | 2.5 CP \( \Rightarrow 75.0 \text{ h} \) |

<table>
<thead>
<tr>
<th><strong>Learning outcomes</strong></th>
<th><strong>Disciplinary knowledge</strong></th>
</tr>
</thead>
</table>
| | - concepts, theories & definitions  
  principles of mass transport in porous media, transport processes.  
- subject matter (factual data, examples)  
  transport in heterogeneous sub-surface, solute transport, colloid transport, multiphase flow and transport, feedback mechanisms, groundwater remediation.  
- methods & procedures  
  mass balances, modelling approaches. |

| **Assessment specification** | **Written** ---  
**Oral** 30 min = module exam “Stoffumsatz und Transport im Untergrund” together with LV Geochemische Stoffkreisläufe |
| **Contact** | ulf.mohrlok@kit.edu |

---

* WCH = Weekly Contact Hours
# Gewässergüte (Fresh Water Quality Assessment)

## Relevance for ResEngin curriculum
- Compulsory elective

## Administration
- Inst. f. Wasser & Gew. entw.
- Stephan.Fuchs@kit.edu

## Contact
- stephan.fuchs@kit.edu

## Term(s) offered
- 2nd (Summer Apr–Sept) + 3rd (Winter Oct–Mar)

## Duration | Cycle
- 2 terms; every year

## Language of instruction
- German

## Prerequisites
- Bachelor, German language proficiency at DSH level

## Module coordinator
- Fuchs, Dr.-Ing. Stephan; IWG-SWW

## Learning outcomes
- Reference list
  - see p. 3.

## Literature / Course materials
- Reference list
  - see p. 3.

## Basis for module(s)
- Not applicable

## Intersection with module(s)
- M 2 Waste and Waste Water Technologies
- M 5 Protection and Use of Riverine Systems
- M 7 Integrated Projects

## Lecture courses
- Gewässerökologisches Praktikum (labcourse, excursion) 2.0 CP 1 week
- Stoffstromanalysen / Wassergütewirt. (lecture) 3.0 CP 2 WCH
- Gewässergüte 3.0 CP 2 WCH + 1 WCH

## Workload specification
- 5 x 30 h = 150 h
  - Lecture Phase: Contact hours
    - Self instruction hours 42.0 h
    - Excursion 24.0 h
    - Exam Preparation 20.0 h
  - Exam Phase: Self instruction hours 32.0 h

## Module examination(s)
- Gewässerökologisches Praktikum report 2.000 words 2.0/5.0 CP
- Gewässergüte oral 30 min 3.0/5.0 CP

## Lecturers
- Fuchs, Dr.-Ing. Stephan; IWG-SWW

## Individual lecture courses
- Descriptions + Recommended background knowledge see pp. 4.
Module T2c: “Fresh Water Quality Assessment” (cont.)

Module topic

Complexity of interactions between abiotic and biotic components of aquatic ecosystems and their relevance for technical systems; relevant causal mechanism operating and controlling aquatic ecosystems.

Learning outcomes

**Disciplinary knowledge**

- **concepts, theories & definitions**
  Functional relation in aquatic ecosystems, food and energy web, river continuum concept, sprobic index.
  Natural and anthropogenic water; nutrient and pollutant cycles; river basin, water body, EU-Water Framework Directive.

- **subject matter (factual data, examples)**
  Longitudinal profile of rivers, daily variation of physico/chemical parameters, oxygen balance of the flowing and stagnant waters, interaction of sediments and water, interstitial chemistry in sediment profiles, assessment of water quality of the river Neckar and its affluents.
  Balance of nutrient and pollutant input into European river basins; nutrient and pollutant loads in European rivers.

- **methods & procedures**
  Water and sediment sampling, chemical analysis, biological assessment.
  Methodology for the assessment of emissions related to different kind and intensity of land use (urbanization, agricultural and industrial production); data collection and analysis and aggregation; data acquisition; monitoring strategies; instruments of material flux analysis.

**Professional skills**

- Application of water and sediment sampling, chemical analysis, biological assessment.
- System thinking, decision making, problem identification and problem solving.

**Personal competence**

- Field methods.
Module T2c: “Fresh Water Quality Assessment” (cont.)

Literature/ Course material


### Module T2c

**Gewässergüte**  
(Fresh Water Quality Assessment)

### Course

**Gewässerökologisches Praktikum**  
(Field Course on Fresh Water Quality)

<table>
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### Lecturer(s)

FUCHS, Dr.-Ing. Stephan; IWG-SWW

### Course topic

Complex interaction of abiotic and biotic components of aquatic ecosystems and their relevance for technical systems; relevant causal mechanism operating and controlling aquatic ecosystems.

### Learning outcomes

**Disciplinary knowledge**

- **concepts, theories & definitions**  
  functional relation in aquatic ecosystems, food and energy web, river continuum concept, sprobic index.

- **subject matter (factual data, examples)**  
  longitudinal profile of rivers, daily variation of physico/chemical parameters, oxygen balance of the flowing and stagnant waters, interaction of sediments and water, interstitial chemistry in sediment profiles, assessment of water quality of the river Neckar and its affluents.

- **methods & procedures**  
  n.a.

**Professional skills**

Application of water and sediment sampling, chemical analysis, biological assessment.

### Personal competence

Field methods.

### Assessment specification

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<td>oral ---</td>
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<td>other group report (2.000 words)</td>
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* WCH = Weekly Contact Hours
Module T2c

Course

Stoffstromanalysen / Wassergüte (Material Flux Analysis in River Basins)

**Module T2c**

**Gewässergüte**

(Fresh Water Quality Assessment)

**Course**

**Stoffstromanalysen / Wassergüte**

(Material Flux Analysis in River Basins)

---

**KIT lecture ID**

xxxxx

**Workload specification**

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**Contact**

stephan.fuchs@kit.edu

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**Lecturer(s)**

FUCHS, Dr.-Ing. Stephan; IWK-SWW

---

**Course topic**

Stress on water quantity and quality due to urbanization and more intensive agricultural and industrial production in developing countries.

---

**Recommended background knowledge**

Fundamentals of Biology, Chemistry and Hydrology

---

**Learning outcomes**

**Disciplinary knowledge**

- concepts, theories & definitions
  - natural and anthropogenic water; nutrient and pollutant cycles; river basin, water body, EU-Water Framework Directive.
- subject matter (factual data, examples)
  - balance of nutrient and pollutant input into European river basins; nutrient and pollutant loads in European rivers.
- methods & procedures
  - methodology for the assessment of emissions related to different kind and intensity of land use (urbanization, agricultural and industrial production); data collection and analysis and aggregation; data collection; monitoring strategies; instruments of material flux analysis.

**Professional skills**

System thinking, decision making, problem identification and problem solving.

**Personal competence**

n.a.

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**Assessment specification**

written ---
oral 30 min = partial module exam “Gewässergüte”
other ---

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* WCH = Weekly Contact Hours