# Hydraulic and Environmental Engineering  
**RESE M 1**

## Relevance for ResEngin curriculum
Compulsory

### Administration
ResEngin Office

### Contact
res.eng@bgu.uka.de

## Term(s) offered
1st term (Winter term Oct- Mar)

## Duration | Cycle
1 term; every other year

## Language of instruction
English

## Prerequisites
Bachelor

## Module coordinator
NESTMANN, Dr.-Ing. Dr.h.c.mult. Franz, Ord.; IWG-WK  [Modulverantwortlicher]

## Learning outcomes
Description see p. 2.

## Literature / Course materials
Reference list see pp. 3.

## Basis for module(s)
- M 4 Soil and Groundwater Resources
- M 5 Protection & Use of Riverine Systems
- M 7 Integrated Projects; M 8 Intercultural Communication
- M MSc Masterarbeit

## Intersection with module(s)
- M T1a Experimental fluid mechanics; M T1b Hydropower engineering
- M T1c Numerical water mgmt planning tools; M T1d Waterway engin.

## Lecture courses
<table>
<thead>
<tr>
<th>Training mode</th>
<th>Course</th>
<th>CP</th>
<th>WCH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19601</td>
<td>3.0</td>
<td>2 WCH</td>
</tr>
<tr>
<td></td>
<td>Environmental Physics (incl. labcourse)</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Applied Hydrology and Hydraulics (lecture, exercise)</td>
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<tr>
<td></td>
<td>19603</td>
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<tr>
<td></td>
<td>Fluvial Hydraulics (lecture, exercise)</td>
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**SUM** 9.0 CP 6 WCH

## Workload specification
(30 work hours → 1 CP acc. to ECTS) 9 x 30 h  270 h

### Lecture Phase:
- Contact hours 52.5 h
- Self instruction hours 105.0 h
- Exercise 10.5 h
- Exam preparation 21.0 h

### Exam Phase:
- Self instruction hours 81.0 h

## Module examination(s)
<table>
<thead>
<tr>
<th>Mode</th>
<th>Scope</th>
<th>Weighting</th>
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<tbody>
<tr>
<td>&quot;Environmental Physics&quot;</td>
<td>oral</td>
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<tr>
<td>&quot;Hydraulics&quot;</td>
<td>written</td>
<td>60 min</td>
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## Lecturers
(in alphabetic order)
- BIEBERSTEIN, Dr.-Ing. Andreas; IBF
- KRON, Dr.-Ing. Andreas; IWG-WK
- MOHRLOK, PD Dr.rer.nat. Ulf; IfH
- NESTMANN, Dr.-Ing. Dr.h.c.mult. Franz, Ord.; IWG-WK
- SCHUHMANN, Dr.-Ing- Rainer; CMM

## Individual lecture courses
Descriptions + Recommended background knowledge see pp. 4.
Module 1: “Hydraulic and Environmental Engineering” (cont.)

Module topic

Sustainable usage of energy and other natural resources based on knowledge about the nature of flows and water balances; the importance of coupled processes in water resources; modeling nature of hydraulic and hydrologic theories; the reliability and uncertainty in measured data; flow phenomena of river streams, interactions and conflicts of multiple use of water.

Learning outcomes

Disciplinary knowledge

- **concepts, theories & definitions**
  Renewable and non-renewable sources of energy and natural resources; energy concept and energy balance; hybrid energy systems; pedology; soil mechanics; geo-hydraulic; single source energy systems.
  Boundary layers; jet hydraulics; transport processes; runoff processes; storage concepts.
  Multi-purpose use of water – interactions and conflicts; conservation of mass, energy & momentum; flow formulas, turbulent flow characteristics, friction forces, morphology, physical modelling.

- **subject matter (factual data, examples)**
  Design and optimization of solar thermal systems; micro hydropower; design of ‘Pumps as Turbines’ for remote micro hydro; transportation phenomena in the environment; physics of the atmosphere; power generation (wind power; hydrodynamic power; geothermal energy); regulation and monitoring of energy generation plants; current KIT research projects.
  Hydraulic machinery; cavitation; flow control; transport and mixing; time series analysis; runoff modelling; storage models; flood prevention; ecosystems interactions
  Properties of river streams, fluid mechanics.

- **methods & procedures**
  Mineralogical analyses; soil mechanical testing and analyses; measurement of soil moisture content; identification and determination of minerals; features of measuring moisture in different kind of soils and materials.
  Application of basic hydraulic formulas; application of continuity equation, momentum equation, energy equation, hydrologic balance approaches; hydraulic analyses.

Professional skills

- Gain expertise in testing in soil mechanics and geo-hydraulics; critical thinking, conclusions from experimental data to theory. Handling energy generation, a controversial subject, and environment in the context of a sustainable usage. Description of environmental phenomena and their use in the sense of energy generation.

- Critical faculties in questioning theories, their applications, and results obtained. To think critically and act rationally to evaluate situations, solve problems and make decisions; ability to read and criticize reports and research papers.

- Gain expertise in understanding the basic physical processes and natural phenomena in rivers, evaluate and analyse major hydraulic flow parameters, design of physical models, critical thinking on effects of human interference in river systems.

Personal competence

- To initiate projects independently. To identify a “resources engineer’s” role in the renewable energy market.

- Self-confidence.
Module 1: “Hydraulic and Environmental Engineering” (cont.)

Literature/ Course material

Module 1: “Hydraulic and Environmental Engineering” (cont.)

Literature/ Course material (cont.)


Module 1

Hydraulic and Environmental Engineering

Course

Environmental Physics (incl. labcourse)

<table>
<thead>
<tr>
<th>KIT Lecture ID</th>
<th>19601</th>
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<td>Term(s)</td>
<td>1st term (winter)</td>
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<td>Language</td>
<td>English</td>
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<tr>
<td>Training mode</td>
<td>Lecture, 2 WCH *</td>
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<td>Workload</td>
<td>3.0 CP ⇒ 90.0 h</td>
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</table>

**Workload specification**

**LECTURE PHASE**
- Contact (based on 2 WCH) 21.0 h
- Self instruction 42.0 h

**EXAM PHASE**
- Self-instruction 27.0 h

**Contact**
riester@kit.edu

**Lecturer(s)**
NESTMANN, Dr.-Ing. Dr.hc.mult. Franz, Ord.; IWG-WK,
BIEBERSTEIN, Dr.-Ing. Andreas; IBF; SCHUHMANN, Dr.-Ing, Rainer; CMM

**Course topic**
Sustainable usage of energy and other natural resources; the nature of fluids and flows; how hydraulic problems can be described and solved; of the modeling nature of hydraulic theories.

**Recommended background knowledge**
Fundamentals of engin. physics & mathematics; statics & dynamics; field experience.

**Learning outcomes**

**Disciplinary knowledge**
- concepts, theories & definitions
  renewable and non-renewable sources of energy and natural resources; energy concept and energy balance; hybrid energy systems; pedology; soil mechanics; geo-hydraulic; single source energy systems.
- subject matter (factual data, examples)
  design and optimization of solar thermal systems; micro hydro power; design of ‘Pumps as Turbines’ for remote micro hydro; transportation phenomena in the environment; physics of the atmosphere; power generation (wind power; hydrodynamic power; geothermal energy); regulation and monitoring of energy generation plants; current research projects at KIT.
- methods & procedures
  mineralogical analyses; soil mechanical testing and analyses; measurement of soil moisture content; identification and determination of minerals; features of measuring moisture in different kind of soils and materials.

**Professional skills**
Gain expertise in testing in soil mechanics and geo-hydraulics; critical thinking, conclusions from experimental data to theory. Handling energy generation, a controversial subject, and environment in the context of a sustainable usage. Description of environmental phenomena and their use in the sense of energy generation

**Personal competence**
To initiate projects independently. To identify a “resources engineer’s” role in the renewable energy market.

**Assessment specification**
written ---
oral 20 min = partial module exam “Environmental Physics”
other ---

*WCH = Weekly Contact Hours*
Module 1

Hydraulic and Environmental Engineering

Course

Applied Hydrology and Hydraulics

**KIT lecture ID**: 19602

**Relevance**: compulsory

**Prerequisites**: Bachelor

**Term(s)**: 1st term (winter)

**Language**: English

**Training mode**: Lecture, 2 WCH *

**Workload**: 3 CP ⇒ 90.0 h

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<th>Exam Phase</th>
<th>Workload</th>
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</thead>
<tbody>
<tr>
<td>Self instruction</td>
<td>27.0 h</td>
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**Contact**

ulf.mohrlok@kit.edu

**Lecturer(s)**

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

**Course topic**

The nature of flows and water balances; the importance of coupled processes in water resources; modeling nature of hydraulic and hydrologic theories; the reliability and uncertainty in measured data.

**Recommended background knowledge**

Fundamentals of mathematics, hydrology, and hydraulics.

**Learning outcomes**

**Disciplinary knowledge**

- concepts, theories & definitions
  - boundary layers; jet hydraulics; transport processes; runoff processes; storage concepts.
- subject matter (factual data, examples)
  - hydraulic machinery; cavitation; flow control; transport and mixing; time series analysis; runoff modelling; storage models; flood prevention; ecosystems interactions.
- methods & procedures
  - measurement methods; application of continuity equation, momentum equation, energy equation, hydrologic balance approaches.

**Professional skills**

Critical faculties in questioning theories, their applications, and results obtained. To think critically and act rationally to evaluate situations, solve problems and make decisions; ability to read and criticize reports and research papers.

**Personal competence**

Self-confidence.

**Assessment specification**

written 60 min = partial module exam “Hydraulics”

oral --- together with LV Fluvial Hydraulics

other ---

* WCH = Weekly Contact Hours
### Module 1

Hydraulic and Environmental Engineering

### Course

**Fluvial Hydraulics**

<table>
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<th>Prerequisites</th>
<th>Term(s)</th>
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<th>Workload</th>
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<tr>
<td>19603</td>
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<td>Bachelor</td>
<td>1st term (winter)</td>
<td>English</td>
<td>Lecture, 1 WCH * Exercise, 1 WCH</td>
<td>3 CP</td>
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> 90.0 h

#### Workload specification

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<tr>
<td>Exercise</td>
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<tr>
<td>Exam preparation</td>
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<tbody>
<tr>
<td>Self-instruction</td>
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#### Contact

andreas.kron@kit.edu

#### Lecturer(s)

NESTMANN, Dr.-Ing. Dr.hc.mult. Franz, Ord.; IWG-WK
KRON, Dr.-Ing. Andreas; IWG-WK

#### Course topic

Flow phenomena of river streams, interactions and conflicts of multi-purpose use of water.

Recommended background knowledge

Fundamentals of mathematics & physics.

#### Learning outcomes

**Disciplinary knowledge**

- concepts, theories & definitions
  - multi-purpose use of water – interactions and conflicts; conservation of mass, energy and momentum; flow formulas, turbulent flow characteristics, friction forces, morphology, physical modeling.
  
- subject matter (factual data, examples)
  - properties of river streams, fluid mechanics.

- methods & procedures
  - hydraulic analyses, application of basic hydraulic formulas.

**Professional skills**

Gain expertise in understanding the basic physical processes and natural phenomena in rivers, evaluate and analyse major hydraulic flow parameters, design of physical models, critical thinking on effects of human interference in river systems.

**Personal competence.**

n.a.

#### Assessment specification

written 60 min = partial module exam “Hydraulics” together with LV Applied Hydrology and Hydraulics
oral ---
other ---

* WCH = Weekly Contact Hours
## Waste and Waste Water Technologies

**Relevance for ResEngin curriculum**

compulsory

<table>
<thead>
<tr>
<th>Administration</th>
<th>Contact</th>
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<tbody>
<tr>
<td>ResEngin Office</td>
<td><a href="mailto:res.eng@bgu.uka.de">res.eng@bgu.uka.de</a></td>
</tr>
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**Term(s) offered**

1st term (Winter term Oct-Mar)

**Duration | Cycle**

1 term; every other year

**Language of instruction**

English

**Prerequisites**

Bachelor

**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)**

- M 5 Protection & Use of Riverine Systems
- M 7 Integrated Projects
- M MSc Masterarbeit

**Intersection with module(s)**

- M T2a Air, Water, and Soil Purification Processes

### Lecture courses (training mode)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Weekly Hours</th>
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<tr>
<td>19608</td>
<td>Waste Water Biotechnology (lecture)</td>
<td>3.0 CP</td>
<td>2 WCH</td>
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<tr>
<td>19609</td>
<td>Non Thermal Waste Treatment &amp; Waste Management (lecture)</td>
<td>3.0 CP</td>
<td>2 WCH</td>
</tr>
<tr>
<td>19606</td>
<td>Waste Water &amp; Waste Analysis (labcourse, excursion; limited seats)</td>
<td>3.0 CP</td>
<td>2 weeks</td>
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</table>

**SUM**

- 9.0 CP
- 4 WCH
- + 2 wks

**Workload specification**

(30 work hours → 1 CP acc. to ECTS)

- 9 x 30 h = 270 h

**Lecture Phase:**

- Contact hours: 42 h
- Self instruction hours: 104 h
- Lab work: 45 h

**Documentation:**

- Protocol: 10 h
- Group report: 15 h

**Exam Phase:**

- Self instruction hours (6 x 9h): 54 h

**Module examination(s)**

- "Waste Water & Waste Water Technologies" written | 60 min | 9.0/9.0 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 2: “Waste and Waste Water Technologies” (cont.)

Module topic

Principal technologies and bio-chemical reactions of wastewater and waste treatment processes including management practices and environmental policy, bio-chemical analysis of wastewater parameters to describe process efficiency. Basic design examples.

Learning outcomes

Disciplinary knowledge

- **concepts, theories & definitions**
  Wastewater treatment covering decentralized simple treatment facilities for small settlements, e.g. lagoon or pond systems, to technically sophisticated treatment plants with aerobic wastewater and anaerobic sludge treatment for mega cities.
  Definition of waste, waste management practices in Germany and in the EU; waste collection/transportation, waste treatment options for different types of waste.
  Analysis of parameters dealing with carbon and nitrogen removal, methane production and toxicity according to standard methods.

- **subject matter (factual data, examples)**
  Process technologies as well as the chemical and biological background: examples from praxis.
  Possible waste treatment options according to the respective waste policies.
  Analytical tools to evaluate or to design a technological process.

- **methods & procedures**
  Mechanical, chemical and biological means to treat domestic wastewater, including activated sludge treatment, pond systems and constructed wetlands; sum parameters and boundary values as a tool for process efficiency description.
  Composting of green waste, fermentation of biowaste, mechanical biological waste treatment of residual waste, sanitary landfill of pre-treated waste.
  Characterize wastewater samples with the most important (bio-)chemical analytic approaches; microscopic characterization of activated sludge; methane production potential; toxicity tests.

- **critical awareness of** the interaction between biochemical and engineering aspects of the respective processes; evaluation of analyzed data, their impact on processes and data reliability.

Professional skills

- To apply wastewater treatment technologies; to decide on a rational basis which treatment system would be appropriate for a certain settlement structure.
- To perform analytical tests, including evaluation of the results and discussing reliable and representative sample withdrawal, possible analytical errors and importance of the results for planning wastewater treatment plants. To learn which analytical data are required and how to deal with these analytical data for basic process planning.

Personal competence

- Synopsis of the content from the previous lecture presented by individual students.
- Presentation of country specific data e.g. costs for waste collection and treatment acc. to respective BIP.
- Team work and time management.
Module 2: “Waste and Waste Water Technologies” (cont.)

Literature/ Course material


Lecture notes

- (1) “Non Thermal Waste Treatment & Waste Management": weekly download of lecture material
Waste Water Biotechnology

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<thead>
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<tr>
<td>Term(s)</td>
<td>1st term (winter)</td>
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<td>Language</td>
<td>English</td>
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<tr>
<td>Training mode</td>
<td>Lecture, 2 WCH *</td>
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<tr>
<td>Workload</td>
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**Workload specification**

<table>
<thead>
<tr>
<th>LECTURE PHASE</th>
<th>21.0 h</th>
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<tbody>
<tr>
<td>Contact (based on 2 WCH)</td>
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<tr>
<td>Self instruction</td>
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<table>
<thead>
<tr>
<th>EXAM PHASE</th>
<th>27.0 h</th>
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<tbody>
<tr>
<td>Self instruction</td>
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</table>

**Contact**
josef.winter@kit.edu

**Lecturer(s)**

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

**Course topic**

The connection between biochemical and engineering aspects of waste treatment processes.

**Recommended background knowledge**

- Fundamentals of natural sciences (biology, chemistry), engineering, and ecology.

**Disciplinary knowledge**

- **concepts, theories & definitions**
  wastewater treatment covering decentralized simple treatment facilities for small settlements, e.g. lagoon or pond systems, to technically sophisticated treatment plants with aerobic wastewater and anaerobic sludge treatment for mega cities.

- **subject matter (factual data, examples)**
  process technologies as well as the chemical and biological background.

- **methods & procedures**
  mechanical, chemical and biological means to treat domestic wastewater including activated sludge treatment, pond systems and constructed wetlands; sum parameters and boundary values as a tool for process efficiency description.

**Professional skills**

To apply wastewater treatment technologies; to decide on a rational basis which treatment system would be appropriate for a certain settlement structure.

**Personal competence**

Synopsis of the content from the previous lecture presented by individual students.

**Assessment specification**

- **written** 60 min = module exam "Waste & Waste Water Technologies" together with LV Non Thermal Waste Treatment & Waste Mgmt & LV Waste Water & Waste Analysis (lab)
- **oral** ---
- **other** ---

* WCH = Weekly Contact Hours
Module 2

Waste and Waste Water Technologies

Course

Non Thermal Waste Treatment & Waste Management

<table>
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**Workload specification**

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<tbody>
<tr>
<td></td>
<td>Self instruction</td>
<td>42.0 h</td>
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</table>

| EXAM PHASE    | Self instruction          | 27.0 h |

**Contact**

claudia.gallert@kit.edu

**Lecturer(s)**

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

**Course topic**

The connection between biochemical and engineering aspects of waste treatment processes.

**Recommended background knowledge**

Fundamentals of natural sciences (biology, chemistry), engineering, and ecology.

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  definition of waste, waste management practices in Germany and in the EU; waste collection/transportation, waste treatment options for different types of waste.

- **subject matter (factual data, examples)**
  possible waste treatment options according to the respective waste policies; process technologies as well as the chemical and biological background; examples from praxis.

- **methods & procedures**
  composting of green waste, fermentation of biowaste, mechanical biological waste treatment of residual waste, sanitary landfill of pre-treated waste.

**Professional skills**

To apply waste treatment technologies; to decide on a rational basis which treatment system would be the appropriate for a certain settlement structure.

**Personal competence**

Presentation of country specific data e.g. costs for waste collection and treatment according to the respective BIP.

**Assessment specification**

- written 60 min = module exam “Waste & Waste Water Technologies”
  together with LV Waste Water Biotechnology & LV Waste Water & Waste Analysis (lab)

- oral ---
- other ---

* WCH = Weekly Contact Hours
Module 2

Waste and Waste Water Technologies

Course

Waste Water & Waste Analysis (labcourse)

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<td>Training mode</td>
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<tr>
<td>Workload</td>
<td>3 CP (\Rightarrow) 90.0 h</td>
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**Workload specification**

<table>
<thead>
<tr>
<th>Lecture Phase</th>
<th>Self Study (course pack)</th>
<th>15.0 h</th>
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<tr>
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<td>Instruction (lab work)</td>
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<td>Protocol</td>
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<td>Group report</td>
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<tr>
<td>Exam Phase</td>
<td>Exam Preparation</td>
<td>9.0 h</td>
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**Contact**

claudia.gallert@kit.edu

**Lecturer(s)**

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

+ scientific research assistants at IBA

**Course topic**

The evaluation of analyzed data, their impact on processes and data reliability.

**Recommended background knowledge**

Manual skills in lab work, fundamentals of statistics.

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  analysis of parameters dealing with carbon and nitrogen removal, methane production and toxicity according to standard methods.

- **subject matter (factual data, examples)**
  analytical tools to evaluate or to design a technological process.

- **methods & procedures**
  to characterize wastewater samples with the most important (bio-)chemical analytic approaches; microscopic characterization of activated sludge; methane production potential; toxicity tests.

**Professional skills**

To perform analytical tests, including evaluation of the results and discussing reliable and representative sample withdrawal, possible analytical errors and importance of the results for planning wastewater treatment plants. To learn which analytical data are required and how to deal with analytical data for basic process planning.

**Personal competence**

Team work and time management.

**Assessment specification**

written 60 min = module exam “Waste & Waste Water Technologies”

together with LV Waste Water Biotechnology & LV Non Thermal Waste Treatment & Waste Mgmt

oral ---

other ---

* WCH = Weekly Contact Hours
# Geoinformatics

**RESE M 3**

<table>
<thead>
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<th>compulsory</th>
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<th>Contact</th>
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<tr>
<th>Learning outcomes</th>
<th>Description</th>
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<th>Literature / Course materials</th>
<th>Reference list</th>
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### Lecture courses

**19605 Remote Sensing & GIS**

- Training mode: lectures, exercise
- Duration: 3.0 CP / 2 WCH

**19604 Terrestrial & Satellite Positioning**

- Training mode: lectures, demonstrations
- Duration: 3.0 CP / 2 WCH

**19620 Probability & Statistics**

- Training mode: lectures, exercise
- Duration: 3.0 CP / 2 WCH

**SUM 9.0 CP / 6 WCH**

<table>
<thead>
<tr>
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<th>(30 work hours → 1 CP acc. to ECTS) 9 x 30 h 270 h</th>
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</thead>
</table>

**Lecture Phase:**

- Contact hours: 63 h
- Self instruction hours: 126 h

**Exam Phase:**

- Self instruction hours:
  - 1st term: 27 h
  - 2nd term: 54 h

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<tr>
<th>Module examination(s)</th>
<th>“Remote Sensing &amp; GIS” oral</th>
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<td>“Geostatistics” report</td>
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<td>HECK, Dr.-Ing. Bernhard; Ord.; GIK</td>
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<td>KIRCH, Dr.rer.nat. Claudia, JProf.; Institut für Stochastik</td>
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<th>Individual lecture courses</th>
<th>Descriptions + Recommended background knowledge see pp. 4.</th>
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</table>
### Module 3: “Geoinformatics” (cont.)

#### Module topic

The module enables students to understand and to apply surveying methods including remote sensing. It provides tools for data processing including statistics and uncertainties as well as for spatial data management and visualization. Students will gain insight into processing and interpretation chains of geoinformatics; covering data acquisition techniques, data filtering, statistical assessment, model assimilation, and critical evaluation.

#### Learning outcomes

**Disciplinary knowledge**

- **concepts, theories & definitions**
  Electromagnetic spectrum; sensors and data of remote sensing, image processing; strategy of development of GIS, definition and example, standardization; cartographic aspects: reference and coordinate systems, basics of cartography, deformation and rectification, digital terrain models.
  Principles of optical systems, definition of reference systems, satellite positioning: GNSS segments, error sources, DGPS, static and RTK mode.
  Random experiments, events, probability, conditional probability, independent events, random variables, probability distribution, density, sample mean, sample variance, sample correlation, point estimate, confidence interval, test, error propagation, linear regression.

- **subject matter (factual data, examples)**
  Data processing: histograms, multispectral classification, quality assessment; examples of remote sensing applications.
  Point/position, height and volume calculation; hydrographic surveys.

- **methods & procedures**
  Terrestrial surveying: methods (point signalization, distance and angle measurement, 3D-positioning), and introduction to instruments (theodolites, levels and total stations)
  Satellite positioning: GNSS description, signals, error sources and error reduction, processing strategies, absolute and differential GNSS, real-time, post-processing, planning a GNSS project.
  Check of models against reality (statistics).

- **critical awareness of** pros and cons of different sensors, imaging types and interpretation approaches.
  dimensional relationships and their uncertainties, properties of data managing methods.

**Professional skills**

- Diagnostic competence, analytical skills, problem solving for surveying tasks.
- Autonomous learning, strategies for meeting future challenges.

**Personal competence**

- n.a.
Module 3: “Geoinformatics” (cont.)

Literature/ Course material


Lecture notes
Module 3

Geoinformatics

Course

Remote Sensing & Geoinformations Systems

<table>
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**Workload specification**

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<tbody>
<tr>
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</table>

**Contact**

stefan.hinz@kit.edu

**Lecturer(s)**

HINZ, Dr.-Ing. Stefan, Ord.; IPF

**Course topic**

Pros and cons of different sensors, imaging types and interpretation approaches.

**Recommended background knowledge**

n.a.

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  electromagnetic spectrum; sensors and data of remote sensing, image processing; strategy of development of GIS, definition and example, standardization; cartographic aspects: reference and coordinate systems, cartography, deformation and rectification, digital terrain models.

- **subject matter (factual data, examples)**
  data processing: histograms, multispectral classification, quality assessment; examples of Remote Sensing Applications.

- **methods & procedures**
  sensors and systems: Airborne vs. satellite platforms, metric cameras, scanner, radar; exercise: Introduction to GIS and Remote Sensing Software, Multi-spectral classification, evaluation techniques.

**Professional skills**


**Personal competence**

n.a.

**Assessment specification**

written ---
oral 20 min = partial module exam "Remote Sensing & GIS" (1st term)
other ---

* WCH = Weekly Contact Hours
### Module 3

**Geoinformatics**

#### Course

**Terrestrial & Satellite Positioning**

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</table>

#### Contact

- michael.mayer@kit.edu
- kurt.seitz@kit.edu

#### Lecturer(s)

HECK, Dr.-Ing. Bernhard, Ord.; GIK
HENNES, Dr.-Ing. Maria, Ord.; GIK

#### Course topic

Dimensional relationships.

#### Recommended background knowledge

- Fundamentals of geometric optics, oscillations and waves,
- linear algebra (vectors, coordinate geometry, trigonometry).

#### Learning outcomes

**Disciplinary knowledge**

- **concepts, theories & definitions**
  - principles of optical systems, definition of reference systems,
  - satellite positioning: GNSS Segments, error sources, DGPS, static and RTK mode.
- **subject matter (factual data, examples)**
  - point/position, height and volume calculation; hydrographic surveys.
- **methods & procedures**
  - terrestrial surveying: methods (point signalization, distance, angle and height measurement, 3D-positioning), and introduction to instruments (theodolites, levels and total stations)
  - satellite positioning: GNSS description, signals, error sources and error reduction, processing strategies, absolute and differential GNSS, real-time, post-processing, planning a GNSS project.

**Professional skills**

- Diagnostic competence, analytical skills, problem solving for surveying tasks.

**Personal competence**

- n.a.

#### Assessment specification

- written ---
- oral ---
- other report (5 p.) = partial module exam “Geostatistics” (2nd term) together with LV Probability & Statistics

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* WCH = Weekly Contact Hours
### Course

#### Probability & Statistics

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#### Workload specification

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#### Lecturer(s)

Kirch, Dr. rer. nat. Claudia, JProf.; Institute of Stochastics

#### Course topic

General enhancement of statistical competence.

#### Recommended background knowledge

Advanced calculus.

#### Learning outcomes

**Disciplinary knowledge**

- **concepts, theories & definitions**
  - random experiments, events, probability, conditional probability, independent events, random variables, probability distribution, density, sample mean, sample variance, sample correlation, point estimate, confidence interval, test, error propagation, linear regression.

- **subject matter (factual data, examples)**

- **methods & procedures**
  - check models against reality (statistics).

**Professional skills.**

Autonomous learning, strategies for meeting future challenges.

**Personal Competence**

n.a.

**Assessment specification**

- written ---
- oral ---
- other report (5 p.) = partial module exam "Geostatistics" (2nd term) together with LV Terrestrial & Satellite Positioning

---

* WCH = Weekly Contact Hours
## Soil and Groundwater Resources

### RESE M 4

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<td>MT2b Sub-surface Transport &amp; Transformation</td>
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### Lecture courses (training mode)

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<td>19625</td>
<td>Soil Environment</td>
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<td>2 WCH</td>
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<td>19626</td>
<td>Agricultural Soil Use</td>
<td>3.0 CP</td>
<td>2 WCH</td>
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**SUM** 9.0 CP 6 WCH

### Workload specification

(30 work hours → 1 CP acc. to ECTS) 9 x 30 h 270 h

**Lecture Phase:**
- Contact hours: 63 h
- Self instruction hours: 126 h

**Exam Phase:**
- Self instruction hours: 81 h

### Module examination(s)

- "Soil and Groundwater" written | 60 min | 6.0/9.0 CP
- "Agricultural Soil Use" oral | 20 min | 3.0/9.0 CP

### Lecturers (in alphabetic order)

- MOHRLOK, PD Dr.rer.nat. Ulf; IfH
- HABER, Dr.sc.agr. Norbert; LTZ
- NORRA, PD Dr.rer.nat. Stefan; IfGG

### Individual lecture courses

Descriptions + Recommended background knowledge see pp. 4.
Module 4: “Soil and groundwater Resources” (cont.)

Module topic

Development of soils and their importance for living organisms and sustainable environmental protection; this includes major aspects of chemical, physical and biological processes in soils, development of soils from rock, classification systems and ecosystem-services they provide. Quantitative and qualitative groundwater development; the interaction of flow and transport processes in the heterogeneous subsurface environment; reliability and uncertainty of measured data; and finally the interdependence of plant growth, soil und water.

Learning outcomes

Disciplinary knowledge

- concepts, theories & definitions
  Hydrogeology and hydraulics principles and definitions; flow and transport processes.
  Soil genesis, physical and chemical soil properties, soils as environment for living organisms, world wide distribution of soils, substance fluxes and transformation processes in soils, ecosystem-services of soils, sustainable development.
  Soil fertility; utilization of soil water, nutrients and fertilizers.

- subject matter (factual data, examples)
  One- and two-dimensional flow examples; pumping tests; tracer tests; groundwater recharge, irrigation; groundwater remediation, salt water intrusion.
  Soil assessment, soil protection, soil management.
  Soil erosion; plant pathology and plant protection; energy plants.

- methods & procedures
  Balance approaches; tools for management.
  Methods of soil analyses and assessment, soil classification and mapping.
  Irrigation; use of organic fertilizers.

Professional skills

- To gain expertise in analytical methods for assessments and planning in groundwater management. To apply the above listed disciplinary knowledge.
- Soil determination, soil classification, soil assessment, understanding the role of soils within the environment and ecosystems.
- To analyze the possibilities of a given location for agricultural use (soil, water and other resources). To handle founding concepts of agriculture under restricted conditions regarding resources of water, fertilizers, pesticides. To select a suited agricultural practice to use the given resources most efficiently to establish sustainable agriculture.

Personal competence

- Being able to discuss the role of soils and their value to society and the environment.
Module 4: “Soil and groundwater Resources” (cont.)

**Literature/ Course material**


Sparks, D.L. (2003); Environmental Soil Chemistry. Amsterdam, NL: Academic Press.


**Lecture notes**

## Course

**Groundwater Management**

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<thead>
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### LECTURE PHASE
- Contact (based on 2 WCH) \(21.0 \text{ h}\)
- Self instruction \(42.0 \text{ h}\)

### EXAM PHASE
- Self instruction \(27.0 \text{ h}\)

### Contact
ulf.mohrlok@kit.edu

### Lecturer(s)
MÖHRLOK, PD Dr rer nat. Ulf; IfH

### Course topic
Quantitative and qualitative groundwater development; the interaction of flow and transport processes in the heterogeneous subsurface environment; the reliability and uncertainty in measured data.

### Recommended background knowledge
Fundamentals of hydraulics, hydrogeology.

### Learning outcomes
**Disciplinary knowledge**
- **concepts, theories & definitions**
  - hydrogeology and hydraulics principles and definitions;
  - flow and transport processes.

- **subject matter (factual data, examples)**
  - one- and two-dimensional flow examples; pumping tests; tracer tests;
  - groundwater recharge, irrigation; groundwater remediation, salt water intrusion.

- **methods & procedures**
  - balance approaches; tools for management.

**Professional skills**
To gain expertise in analytical methods for assessments and planning in groundwater management. To apply the above listed disciplinary knowledge.

### Personal competence
n.a.

### Assessment specification
- **written** 60 min = partial module exam “Soil and Groundwater”
- **oral** ---
- **other** ---

* WCH = Weekly Contact Hours
Module 4

Course

Soil and Groundwater Resources

Soil Environment

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**Workload specification**

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</table>

**Contact**

stefan.norra@kit.edu

**Lecturer(s)**

Norra, PD Dr. rer. nat. Stefan; IfGG

**Course topic**

Ecosystem-services of soils and their importance for living organisms, sustainable environmental protection.

**Recommended background knowledge**

Fundamentals of physics, chemistry and biology.

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  - soil genesis, physical and chemical soil properties, soils as environment for living organisms, world wide distribution of soils, substance fluxes and transformation processes in soils, ecosystem-services of soils, sustainable development.
- **subject matter (factual data, examples)**
  - soil assessment, soil protection, soil management.
- **methods & procedures**
  - methods of soil analyses and assessment, soil classification and mapping.

**Professional skills**

Soil determination, soil classification, soil assessment, understanding the role of soils within the environment and ecosystems.

**Personal competence**

Being able to discuss the role of soils and their value to the society and the environment.

**Assessment specification**

written 60 min = partial module exam “Soil and Groundwater” together with LV Groundwater Management
oral ---
other ---

* WCH = Weekly Contact Hours
Module 4

Soil and Groundwater Resources

Course

Agricultural Soil Use

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<tr>
<td>EXAM PHASE</td>
<td>Self instruction</td>
<td>27.0 h</td>
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**Contact**

res.eng@kit.edu

**Lecturer(s)**

HABER, Dr.sc.agr. Norbert; LTZ

**Course topic**

The interdependence of plant growth, soil and water.

**Recommended background knowledge**

Fundamentals of soil science and biology of plants.

**Learning outcomes**

**Disciplinary knowledge**

- **concepts, theories & definitions**
  - contribution of physical and chemical properties of soils to soil fertility; utilization of soil water, nutrients and fertilizers by different plant species (C3, C4).

- **subject matter (factual data, examples)**
  - soil erosion: importance and possibilities to reduce it; plant pathology and plant protection; cultivation of energy plants.

- **methods & procedures**
  - irrigation: technical equipment, management, effectiveness; use of municipal waste, feces and manure from livestock as organic fertilizers.

**Professional skills**

To analyze the possibilities of a given location for agricultural use (soil, water and other resources). To handle founding concepts of agriculture under restricted conditions regarding resources of water, fertilizers, pesticides. To select a suited agricultural practice to use the given resources most efficiently to establish sustainable agriculture.

**Personal competence**

n.a.

**Assessment specification**

written ---
oral 20 min = partial module exam “Agricultural Soil Use”
other ---

* WCH = Weekly Contact Hours