Karlsruher Institut für Technologie

Module Handbook
Geophysics Master (M.Sc.)

SPO 2020 - valid for all students who started winter semester 20/21 or later

Summer term 2023

Date: 20/03/2023

KIT DEPARTMENT OF PHYSICS

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Prologue

Introduction

Karlsruhe Institute of Technology (KIT) has, as part of the implementation of the Bologna Process for the establishment of a European Higher Education Area, decided to provide a Master's degree as the regular certificate at the end of its university studies. KIT therefore sees the consecutive Bachelor's and Master's degree programs offered as an overall concept with a consecutive curriculum. Students from other universities, who fulfill the requirements to study in KIT's Master's program in Geophysics, are equally admitted.

The Study and Examination Regulations (SPO) of the Master's program in Geophysics define a number of 120 ECTS (European Credit Transfer System) credits for the successful completion of the Master's program. Quality assurance is provided by a compulsory thesis, with a working time of six months, awarded with 30 ECTS credits. The regular study duration is four terms (two years) including the thesis.

After completing the Master's examination, a "Master of Science (M.Sc.)" degree is awarded by KIT.

Topics studied are grouped into subjects and those are divided into modules. All modules are listed in the section 'Modules' within this module handbook. With this prologue we provide information that goes beyond the content of the module descriptions. All information refers to the German version of the Study and Examination Regulations (SPO), as of 06.08.2020

Both the German SPO which is legally binding and the English translation (not legally binding) can be found on the web page of our Geophysics Master's program:

https://www.gpi.kit.edu/english/288.php

Geophysics Master's program at KIT

The consecutive Master's program in Geophysics has – while retaining a broad range of expertise – a strongly deepening and profile-forming character. This is illustrated by the focus of the Master's program in applied seismics, seismology and natural hazards. The Master's program thus has a close connection to practical issues and current research topics at the Geophysical Institute. Individual emphases can be set in the compulsory elective courses in the subject "Electives".

This profile-forming requires a solid basic education in the context of a Bachelor's degree program. Accordingly, the KIT-Department of Physics has issued admission requirements. Missing fundamentals in Geophysics can be acquired in mandatory additional studies.

Both, the German Statues for Admission which are legally binding and the English translation (not legally binding) can be found on the web page of our Geophysics Master's program:

https://www.gpi.kit.edu/english/288.php

Of central importance is the thesis, which is preceded by the subjects “Scientific Focusing Phase” and “Introduction to Scientific Practice”. There, key qualifications are acquired in an integrative manner (goal-oriented work, measurement technology, protocol management, teamwork, study of literature, formulation of scientific questions, defense of own work results, etc.). Additive key qualifications amounting to four ECTS credits are acquired as part of the courses offered by KIT.

2 Qualification Objectives

Students of the Geophysics Master's program know and understand the scientific basics of general and applied geophysics. The students understand the theory of seismic waves and can calculate the solution of the elastic wave equation for the general and special cases. They know the principles of inversion of seismic waves and can apply them. They understand measurement procedures used in Geophysics, can explain and compare a variety of measurement principles and know how to perform an objective and detailed error analysis of the measurement results. They can process and analyze seismic signals of different frequency ranges and assess seismic analyses. In the field of reflection seismics and array seismology, students are familiar with the working steps from data acquisition to analysis and are able to carry them out on their own. Students who have obtained their Bachelor's degree outside KIT may require to complete basic courses in the field of signal processing in the subject “Electives”, unless they have already acquired these qualifications in their previous studies.

The graduates understand geoscientific and physical context beyond the field of Geophysics, they can discuss and interpret it. Based on the acquired knowledge, they correctly classify topics and have the practical ability to solve tasks of geophysics and neighboring geoscientific disciplines.

They have the ability to deduce relationships from measured data, to formulate complex models, to derive predictions and to verify or falsify them using advanced methods like inversion of data. Graduates can apply knowledge of Geophysics to research-related questions and are able to analyze and solve technical problems using geophysical methods including software and hardware. Graduates have competences in clearly summarizing scientific results in written and spoken language and are able to present their work in a didactically appealing manner. The graduates can work independently and have extensive communication skills and organizational skills.

3 Subjects

3.1 Geophysics

The core of the Master’s program is the subject “Geophysics” with 40 ECTS credits. It includes the modules “Seismometry, Signal Processing and Seismogram Analysis” (winter term) and “Theory and Inversion of Seismic Waves” (summer term). Whether one or the other module is completed first depends on the beginning of the study in either winter or

summer term. A start in the summer term (April) is not recommended for students from abroad or students who do not hold a Bachelor's degree in Geophysics. The module content is taught in lectures and exercises as well as individually acquired in self studies. In the subject "Geophysics", a profile is formed according to the research foci of the Geophysical Institute. During the courses the students get to know the research areas of the institute. The lecturers facilitate the contact between students and scientists, regularly provide insight into current research and establish a close connection to current scientific issues in their courses. They also demonstrate and teach good scientific practice according to KIT's Statutes for Safeguarding Good Research Practice.

3.2 Electives

In order to specialize, the students can choose courses for individual profile-forming. Here, additional course offers in the field of Geophysics as well as offers from the neighboring disciplines (Earth sciences, Physics, Engineering, etc.) can be selected and combined on an advanced level. The scope of the courses must sum up to a total of at least 16 ECTS credits.

At least 8 ECTS credits must be earned through graded examinations. The module grade is then calculated as ECTS-weighted average of the individual graded courses. For this purpose, all graded examinations are used for the formation of the technical grade. All other coursework and exams complete the list of not-graded courses until the total of 16 ETCS credits have been reached. The exact nature and extent of the examinations will be announced by the corresponding lecturer at the beginning of the lecture period. Furthermore, the provisions of §8 of the Study and Examination Regulations apply to repeat examinations.

There is only a limited number of courses that are statically stored in the electronic examination system. All examinations which students wish to be credited in the subject "Electives" and which are not selectable in the electronic examination system must first be approved.

Therefore, the following procedure should be observed:

1. Choosing one or more courses for the subject "Electives". In case you chosen courses are not selectable in the electronic examination system, continue with 2.

2. Download a list ('Document for Electives') and enter one or more courses which you would like to choose as Elective. This list will be checked and signed by the official in charge at the Geophysical Institute. The list can be found on the web page of our Geophysics Master's program: https://www.gpi.kit.edu/english/288.php

3. Download and print a "blue form" for each individual course (in color). The top box is to be filled out by the student. A template "blue form" can be found here: https://www.sle.kit.edu/downloads/Sonstige/Pruefungszulassung-Erstversuch.pdf

4. Take the list together with the blue form to the Examination Office (Prüfungssekretariat) at the KIT-Department of Physics. This blue form will then be

signed by Ms Müller at the Examination Office at the KIT-Department of Physics. Contact information and consultation hours can be found here: https://www.physik.kit.edu/Dekanat/

5. Hand the signed blue form over to the examiner of the compulsory elective course.

6. After successfully passing the exam or coursework, the blue form will be sent by the examiner back to the Examination Office of the KIT-Department of Physics, where the result will be entered into the electronic examination system.

3.3 Interdisciplinary Qualifications

In addition to the subject-specific qualifications, at least 4 ECTS credits must be acquired in the subject "Interdisciplinary Qualifications" (also known as professional skills or additive key competences). The corresponding modules from the fields of languages, project management, tutorials, scientific writing or public science are offered by the HoC (House of Competence), ZAK (Center for Cultural and General Studies), "Sprachenzentrum" or "Studienkolleg" at KIT. Other modules require the approval of the Examination Committee.

The certificates of the interdisciplinary qualifications are not graded. Graded offers can be selected but do not contribute to the overall grading. The exact nature and extent of the examinations will be announced by the corresponding lecturer at the beginning of the lecture period. Furthermore, the provisions of §8 of the Study and Examination Regulations apply to repeat examinations.

3.4 Introduction to Scientific Practice, Scientific Focusing Phase and Master's Thesis

The actual work on the Master's thesis is preceded by the subjects "Scientific Focusing Phase" and "Introduction to Scientific Practice". In both subjects sound foundations and key qualifications (in integrative form) for scientific work are taught as preparation for the Master's thesis itself.

In the subject "Introduction to Scientific Practice" students learn basic working methods that are required for successful scientific research. The working methods themselves are independent of a scientific field, but are practiced and learned on the basis of a specific task (topic of the Master's thesis). The students will be guided by the future supervisor of the Master's thesis. As a result, the students submit a written report, which shows that they have adopted the scientific working methods and applied them to the topic of their future Master's thesis. In addition, students attend seminars and colloquia accompanying Geophysics, Geosciences, and Physics. Students gain an overview of current research topics, learn to follow scientific presentations that are outside their area of specialization, and expand their knowledge through appropriate questions to the lecturers and presenters.

In the subject "Scientific Focusing Phase" the students independently work on a specific task that is related to the future Master's thesis. This can be, for instance, performing measurements or creating a computer program or developing a theoretical approach. In this way, the students learn guided by the future supervisor of the Master's thesis essential

working techniques for the processing of their Master's thesis, which are specific to the corresponding scientific field. The students will attend the seminar of the research area in which they will prepare their Master's thesis. In this seminar, they present their work and put their work results to critical discussion. They learn to present their work to third parties and to include suggestions from the scientific discussion for the further proceeding.

Registration: At the beginning of the second year, once the students have found a topic to work on in their Master's thesis, they need to register for their topic of the Master's thesis. The actual work on the Master's thesis is performed during the subjects "Introduction to Scientific Practice" and "Scientific Focusing Phase" and during the module "Master Thesis", and thus during the last year of studies.

For registration, students need to download and print an application form which is found on the web page of the Geophysics Master's program:

https://www.gpi.kit.edu/english/288.php

Afterwards, students visit the Examination Office of the KIT-Department of Physics. There, it is checked that students fulfill all requirements for starting a Master's thesis and, if applicable, the form will be signed.

This form then has to be handed over to the reviewer of the thesis by the student. The reviewer needs to fill in the required fields (start date: 12 months before intended submission) and send the form back to the Examination Office. In parallel, students have to register for all modules in the above mentioned subjects in the electronic examination system. For the thesis itself, no additional registration is necessary.

The thesis is a central component of profiling and deepening. As part of the thesis, the students demonstrate that they can independently analyze a scientific problem under guidance, develop suitable solutions, interpret the results and present the whole in a written document. These are important interdisciplinary skills for any future job. The results of the thesis are presented in a department-public colloquium.

A thesis may only be awarded by examiners according to §17 (2) of the Study and Examination Regulations. It can be carried out as project work in one of the working groups of the department or corresponding groups at the KIT. It is also possible to realize an external thesis outside the department. To do this, a supervisor from the department must be found who is willing to support the external work and obtain the approval of the Examination Committee. A written document is to be prepared on the topic of the thesis. Both the supervisor and the second reviewer each receive a printed and bound copy of the work. In addition, one copy each is to be handed to the Examination Office of the department (exam copy, signed by the supervisor) and to the library of the Geophysical Institute.

4 Registration for Examinations

Registration is done online via the central examination system of the KIT. Examinations and coursework are the evaluated review of achieving the qualification objectives defined in the

module. They are subject-specific, didactically coordinated and immediate. Examinations are written, oral or of other type. Coursework are not-graded reviews and are often required as a prerequisite for examinations.

According to §6 of the Study and Examination Regulations, the actual type of assessment is announced for a module examination in the module handbook. The conditions under which a repetition of written and oral examinations is possible are specified in §8 of the Study and Examination Regulations.

5 Grade

The overall grade of the Master's examination is calculated as an average grade weighted by credit points. The modules from the subjects "Geophysics" and "Electives" are weighted with their credit points and the module "Master Thesis" is weighted with twice the number of credit points.

6 Module Scheme

The tabular module scheme shows the distribution of the modules and the courses they contain within the terms of the study program. The overview of the workload for the degree program is shown in ECTS credits. An ECTS credit corresponds to a workload of 30 hours.

Module Scheme Master Geophysics, SPO 2020, as at 20.03.2023

Sem.	Geophysics		Scientific Focusing Phase, Scientific Seminars and Introduction to Scientific Practice		Compulsary Electives	SQs	Sum CP
1 (**WS**, or SS)	Physics of Seismic Instruments M: Seismometry, Signal Processing and Seismogram Analysis V2Ü1 6	Seismology M: Seismometry, Signal Processing and Seismogram Analysis V2Ü2 8			Compulsary Electives 6	SQs I 2	**1** (**WS**, or SS)
		Seismics M: Seismometry, Signal Processing and Seismogram Analysis V2Ü2 8					
Sum CP	**22**				**6**	**2**	**30**
2 (**SS**, or WS)	Theory of Seismic Waves M: Theory and Inversion of Seismic Waves V2Ü1 6	Seismic Modelling M: Theory and Inversion of Seismic Waves V1Ü1 4			Compulsary Electives 10	SQs II 2	**2** (**SS**, or WS)
		Inversion and Tomography M: Theory and Inversion of Seismic Waves V2Ü2 8					
Sum CP	**18**				**10**	**2**	**30**
3 (**WS**, or SS)			Seismic/Seismology Seminar M: Scientific Focusing Phase S2 10	Introduction to Research in a Scientific Sub-Field incl. a Seminar Paper M: Introduction to Scientific Practice 16			**3** (**WS**, or SS)
				Seminar of the Geophysical Institute or Phys. Colloquium, etc. M: Scientific Seminars S2 4			
Sum CP			**30**				**30**
4 (**SS**, or WS)	Master's Thesis and Colloquium M: Master's Thesis 30						**4** (**SS**, or WS)
Sum CP	**30**						**30**
Module	Seismometry, Signal Processing and Seismogram Analysis: 22		Introduction to Research in a Scientific Sub-Field incl. a Seminar Paper: 16		Electives: 16	SQs: 4	
	Theory and Inversion of Seismic Waves: 18		Seismic/Seismology Seminar: 10				
	Master's Thesis: 30		Seminar of the Geophysical Institute or Phys. Colloquium, etc.: 4				
Total CP	**70**		**30**		**16**	**4**	**120**

3 Field of study structure

Mandatory	
Master's Thesis	30 CR
Geophysics	40 CR
Electives	16 CR
Scientific Focusing Phase	10 CR
Introduction to Scientific Practice	20 CR
Interdisciplinary Qualifications	4 CR
Voluntary	
Additional Examinations *This field will not influence the calculated grade of its parent.*	

3.1 Master's Thesis

Credits
30

Mandatory		
M-PHYS-101730	Modul Master's Thesis	30 CR

3.2 Geophysics

Credits
40

Mandatory		
M-PHYS-101358	Seismometry, Signal Processing and Seismogram Analysis	22 CR
M-PHYS-101359	Theory and Inversion of Seismic Waves	18 CR

3.3 Electives

Credits
16

Elective Studies (Election: at least 16 credits)		
M-BGU-101030	Recent Geodynamics	4 CR
M-PHYS-101355	Modern Physics Laboratory Course	6 CR
M-PHYS-101833	Geological Hazards and Risk	8 CR
M-BGU-101996	Structural Geology and Tectonics	4 CR
M-PHYS-101866	Introduction to Volcanology, graded	4 CR
M-PHYS-101870	The Black Forest Observatory at Schiltach	1 CR
M-PHYS-101872	Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, not graded	3 CR
M-PHYS-101873	Hazard and Risk Assessment of Mediterranean Volcanoes, graded	6 CR
M-PHYS-101946	Near Surface Geophysical Prospecting	1 CR
M-PHYS-101952	Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, graded	4 CR
M-PHYS-101959	Induced Seismicity, graded	5 CR
M-PHYS-101960	Physics of the Lithosphere, graded	3 CR
M-PHYS-101961	Historical Seismology for Hazard Evaluation	1 CR
M-PHYS-103142	Module Wildcard Electives	16 CR
M-PHYS-103141	Geophysical Monitoring of Tunnel Constructions	1 CR
M-PHYS-103803	Seminar on Recent Topics of Risk Science	4 CR
M-PHYS-101354	Classical Physics Laboratory Course II	6 CR
M-PHYS-103855	Near-surface seismic and GPR	6 CR
M-PHYS-103856	3D reflection seismics	1 CR
M-PHYS-104186	Seismic Data Processing with Final Report (graded)	6 CR
M-PHYS-104188	Seismic Data Processing with final report (ungraded)	6 CR
M-PHYS-104189	Seismic Data Processing without Final Report (Ungraded)	2 CR
M-PHYS-104196	In-Situ: Summer School Bandung: Seismology/Geohazards	6 CR
M-PHYS-104522	Full-waveform Inversion, not graded	6 CR
M-PHYS-105279	Geological Hazards and Risk, not graded	8 CR
M-PHYS-105382	Eifel Seismology and Volcanology Course	2 CR
M-PHYS-105383	International Workshop on Current Geophysical Research Topics	2 CR
M-PHYS-105662	Observatory Course *First usage possible from 4/1/2021.*	3 CR
M-PHYS-105679	Physical Methods in Volcano Seismology *First usage possible from 4/1/2021.*	6 CR
M-PHYS-106196	Array Techniques in Seismology, graded *First usage possible from 10/1/2022.*	4 CR
M-PHYS-106198	Array Techniques in Seismology, not graded *First usage possible from 10/1/2022.*	4 CR
M-PHYS-106322	In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region *First usage possible from 4/1/2023.*	6 CR

3.4 Scientific Focusing Phase

Credits
10

Mandatory		
M-PHYS-101360	Scientific Focusing Phase	10 CR

3.5 Introduction to Scientific Practice

Credits
20

Mandatory		
M-PHYS-101357	Scientific Seminars	4 CR
M-PHYS-101361	Introduction to Scientific Practice	16 CR

3.6 Interdisciplinary Qualifications

Credits
4

Mandatory		
M-PHYS-102349	Interdisciplinary Qualifications	4 CR

3.7 Additional Examinations

Additional Examinations (Election: at most 30 credits)		
M-PHYS-102020	Further Examinations	30 CR
M-ZAK-106099	Supplementary Studies on Sustainable Development *First usage possible from 4/1/2023.*	19 CR
M-ZAK-106235	Supplementary Studies on Culture and Society *First usage possible from 10/1/2022.*	22 CR

4 Modules

M 4.1 Module: 3D reflection seismics [M-PHYS-103856]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
1	pass/fail	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-107806	3D reflection seismics	1 CR	Bohlen, Hertweck

Prerequisites
None

Competence Goal
The students refresh and elaborate their knowledge of reflection seismics. They comprehend the fundamentals of seismic data acquisition and learn about practical issues relevant in the field. They participate a field experiment and get to know hardware, procedures used in the field, and relevant people and positions in the field. In the end, students will be familiar with the basics of running field acquisition and collecting land seismic data. They deepen their knowledge of the reflection seismic principles and have a good understanding of practical issues. They are able to apply the principles to other seismic surveys and analyse important field parameters. They comprehend how theory of wave propagation and signal processing relates to practice andthe influence it has onthe field acquisition setup.

Content

- Introduction to 3D reflection seismic
- Land acquisition and land-specific issues
- Field trip and in-situ lecture (1 day):
  a) Introduction to the geological background
  b) Equipment, acquisition procedures, data quality control
- Wrap-up and summary

Workload
30 hours, of which 15 hours contact time, 15 hours homework

Recommendation
Understanding of the basic reflection seismic principles.

M 4.2 Module: Array Techniques in Seismology, graded [M-PHYS-106196]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives (Usage from 10/1/2022)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-112590	Array Techniques in Seismology, graded	4 CR	Ritter

Competence Certificate
Grading is based on written reports on exercises. A detailed rating scheme is distributed during the first lecture together with information on the required length of the reports and rating criteria.

Competence Goal
The students understand basic principles of array techniques. This includes the increase in signal-to-noise ratio due to stacking or beamforming and the estimation of simple shear-wave velocity profiles. They know how to determine the slowness or ray parameter of an incoming wavefield as well as its backazimuth. These parameters are used to estimate the location of a seismic source. Furthermore, they know how to divide different phase arrivals using a vespagram or an f-k analysis.

The students are able to work self-organized on a specific issue of array seismology, e.g., the location of a nuclear test or the local shear-wave velocity structure underneath a local array. They are able to read and understand technical and scientific literature on array seismology. They can outline and analyze seismological cases in which array techniques can solve specific problems such as seismic phase identification or source location estimation.

Content

- Fundamentals of seismic waves
- Measurable parameters of seismic waves using arrays
- Determination of source locations
- Determination of underground properties
- Global seismic arrays and their role for monitoring nuclear tests and earthquakes
- Training on array software and application to seismological data sets

Module grade calculation
Reports on exercises need to be submitted which are individually graded. The final module grade is calculated as average of all individually graded reports. A detailed rating scheme is distributed during the first lecture.

Workload
Total workload: 120h which consist of 15h lecture at GPI, 15h reading of research papers and lecture material, 15h preparation and wrap-up of lecture, 15h guided exercise in the computing room at GPI to learn about array software (basic Linux and Python knowledge required), 30h self-organized training with array software and application to data sets, and 30h preparation of reports on exercises.

Recommendation
Participants need to know the basics of seismology.

Literature

- Schweitzer, J. et al., 2012. Seismic Arrays. In: Bormann, P. (Ed.), New Manual of Seismological Observatory Practice 2 (NMSOP-2), Potsdam, Deutsches GeoForschungsZentrum GFZ, 1-80, doi:10.2312/GFZ.NMSOP-2_ch9
- Rost, S. & Thomas, C., 2002. Array seismology: Methods and applications. Rev. Geophys., 40 (3), 1008, doi:10.1029/2000RG000100
- Kind, F. et al., 2005. Array measurements of S-wave velocities from ambient vibrations. Geophysical Journal International, 160 (1), 114–126, doi:10.1111/j.1365-246X.2005.02331.x

M 4.3 Module: Array Techniques in Seismology, not graded [M-PHYS-106198]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives (Usage from 10/1/2022)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-112593	Array Techniques in Seismology, not graded	4 CR	Ritter

Competence Certificate
Written reports on exercises must be submitted, which are assessed and scored on an individual basis. Successful participation requires that the average score of all reports combined exceeds a certain threshold. Detailed information on the threshold and scoring is distributed in the first lecture.

Competence Goal
The students understand basic principles of array techniques. This includes the increase in signal-to-noise ratio due to stacking or beamforming and the estimation of simple shear-wave velocity profiles. They know how to determine the slowness or ray parameter of an incoming wavefield as well as its backazimuth. These parameters are used to estimate the location of a seismic source. Furthermore, they know how to divide different phase arrivals using a vespagram or an f-k analysis.

The students are able to work self-organized on a specific issue of array seismology, e.g., the location of a nuclear test or the local shear-wave velocity structure underneath a local array. They are able to read and understand technical and scientific literature on array seismology. They can outline and analyze seismological cases in which array techniques can solve specific problems such as seismic phase identification or source location estimation.

Content

- Fundamentals of seismic waves
- Measurable parameters of seismic waves using arrays
- Determination of source locations
- Determination of underground properties
- Global seismic arrays and their role for monitoring nuclear tests and earthquakes
- Training on array software and application to seismological data sets

Workload
Total workload: 120h which consist of 15h lecture at GPI, 15h reading of research papers and lecture material, 15h preparation and wrap-up of lecture, 15h guided exercise in the computing room at GPI to learn about array software (basic Linux and Python knowledge required), 30h self-organized training with array software and application to data sets, and 30h preparation of reports on exercises.

Recommendation
Participants need to know the basics of seismology.

Literature

- Schweitzer, J. et al., 2012. Seismic Arrays. In: Bormann, P. (Ed.), New Manual of Seismological Observatory Practice 2 (NMSOP-2), Potsdam, Deutsches GeoForschungsZentrum GFZ, 1-80, doi:10.2312/GFZ.NMSOP-2_ch9
- Rost, S. & Thomas, C., 2002. Array seismology: Methods and applications. Rev. Geophys., 40 (3), 1008, doi:10.1029/2000RG000100
- Kind, F. et al., 2005. Array measurements of S-wave velocities from ambient vibrations. Geophysical Journal International, 160 (1), 114–126, doi:10.1111/j.1365-246X.2005.02331.x

M 4.4 Module: Classical Physics Laboratory Course II [M-PHYS-101354]

Responsible: Studiendekan Physik
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	pass/fail	Each summer term	1 term	German	4	1

Mandatory			
T-PHYS-102290	Classical Physics Laboratory Courses II	6 CR	Husemann, Simonis, Wolf

Prerequisites
none

M 4.5 Module: Eifel Seismology and Volcanology Course [M-PHYS-105382]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
2	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-110870	Eifel Seismology and Volcanology Course	2 CR	Rietbrock

Competence Certificate
Active attendance of lecture and practicals, discussions and data analysis, preparation of a presentation about scientific literature provided by the lecturers, preparation of a handout as a summary of the presentation.

Prerequisites

- Knowledge in seismology and physics of seismic instruments
- Programming knowledge (preferable Python and ObsPy)

Competence Goal

- Students have gained a basic knowledge and appreciation of the Eifel volcanism. They will understand the basic types of eruption styles in the Eifel region and understand the physical processes behind.
- Students have gained knowledge about the current status of seismicity in the Eifel and understand the current developments.
- Students are able to deploy seismic stations in the field, collect the data and convert the data to commonly used seismic formats. They have gained practical knowledge how to apply instrument corrections and cross-validate seismic records.
- Students are able to summarise and synthesise scientific publications and present their results in written and oral form. They will be able to communicate their view point and scientifically defend this view when challenged by fellow students or lecturers.

Content

- Field installation of different seismometers (short period, broadband, geophone, etc.)
- Data processing and instrument correction
- Introduction to the Eifel volcanism (the geological/earth sciences perspective)
- Introduction to current seismicity in the Eifel
- Careful appreciation of publications and scientific discussion

Module grade calculation
The grade of the module results from grade of the handout. A detailed grading scheme is distributed during the lecture.

Workload

- 4 h: Introductionary lectures/ practicals at GPI before field course
- 20 h: Preparation of presentation and handout, study of additional literature provided by the lecturers (before field course)
- 30 h: Field course
- 6 h: Data analysis at GPI after field course

Learning type
In situ lecture comprising introductionary lectures at GPI, 3 days field course, data analysis at GPI after field course

Literature
Literature will be provided by the lecturer.

M 4.6 Module: Full-waveform Inversion, not graded [M-PHYS-104522]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	pass/fail	Irregular	1 term	English	4	2

Mandatory			
T-PHYS-109272	Full-waveform inversion	6 CR	Bohlen, Hertweck

Competence Certificate
Final pass based on successful participation of the exercises.

Prerequisites
None

Competence Goal
The students know the fundamentals about full-waveform inversion from theory to practical implementation. They understand the basic concept of full-waveform inversion and grid-based finite-difference schemes to solve the wave equation. They understand important practical aspects such as numerical effects and critical performance issues. Students are able to implement a basic full-waveform inversion algorithm and apply it to simple data sets. They can analyze important factors influencing the success of full-waveform inversion and assess the quality of inversion results.

Content

- Introduction to full-waveform inversion (FWI)
- Solution of the wave equation with the finite-difference method
- Practical issues and numerical effects
- Adjoint-state method
- Adaption of the adjoint-state method for FWI
- FWI of shallow seismic wavefields

Module grade calculation
The coursework is not graded.

Workload
180 h hours composed of contact time (45 h), wrap-up of the lectures and solving the exercises (135 h)

Recommendation
Knowledge of differential calculus is essential. Experience with Matlab and general computer skills are beneficial.

Learning type
4060181Seismic Full Waveform Inversion (V2)
4060182 Exercises to Seismic Full Waveform Inversion (Ü1)

Literature

- Andreas Fichtner, "Full Seismic Waveform Modelling and Inversion", 2011, Springer.

M 4.7 Module: Further Examinations [M-PHYS-102020]

Organisation: KIT Department of Physics
Part of: Additional Examinations

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
30	pass/fail	Each term	1 term	German	4	1

Additional Examinations (Election: at most 30 credits)			
T-PHYS-103898	Wildcard Additional Examinations 1	2 CR	
T-PHYS-103937	Wildcard Additional Examinations 11	2 CR	

M 4.8 Module: Geological Hazards and Risk [M-PHYS-101833]

Responsible: Dr. Andreas Schäfer
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	Grade to a tenth	Each winter term	1 term	English	4	5

Mandatory			
T-PHYS-103525	Geological Hazards and Risk	8 CR	Schäfer

Competence Certificate
Active and regular attendance of lecture and practicals. Project work (graded).

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-105279 - Geological Hazards and Risk, not graded must not have been started.

Competence Goal
The students understand basic concepts of hazard and risk. They can explain in detail different aspects of earthquake hazard, volcanic hazard as well as other geological hazards, can compare and evaluate those hazards. The have fundamental knowledge of risk reduction and risk management. They know methods of risk modelling and are able to apply them.

Content

- Earthquake Hazards
  - Short introduction to seismology and seismometry (occurrence of tectonic earthquakes, types of seismic waves, magnitude, intensity, source physics)
  - Induced seismicity
  - Engineering seismology, Recurrence intervals, Gutenberg-Richter, PGA, PGV, spectral acceleration, hazard maps
  - Earthquake statistics
  - Liquefaction
- Tsunami Hazards
- Landslide Hazards
- Hazards from Sinkholes
- Volcanic Hazards
  - Short introduction to physical volcanology
  - Types of volcanic hazards
- The Concept of Risk, Damage and Loss
- Data Analysis and the use of GIS in Risk analysis
- Risk Modelling - Scenario Analysis
- Risk Reduction and Risk Management
- Analysis Feedback and Prospects in the Risk Modelling Industry

Module grade calculation
Project work will be graded.

Workload

- 60 h: active attendance during lectures and exercises
- 90 h: review, preparation and weekly assignments
- 90 h: project work

Learning type
4060121 Geological Hazards and Risk (V2)

4060122 Übungen zu Geological Hazards and Risk (Ü2)

Literature
Literature will be provided by the lecturer.

M 4.9 Module: Geological Hazards and Risk, not graded [M-PHYS-105279]

Responsible: Dr. Andreas Schäfer
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
8	pass/fail	Each winter term	1 term	English	4	1

Mandatory			
T-PHYS-110713	Geological Hazards and Risk, not graded	8 CR	Schäfer

Competence Certificate
Active and regular attendance of lecture and practicals. Project work (not graded).

Prerequisites
none

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-101833 - Geological Hazards and Risk must not have been started.

Competence Goal
The students understand basic concepts of hazard and risk. They can explain in detail different aspects of earthquake hazard, volcanic hazard as well as other geological hazards, can compare and evaluate those hazards. The have fundamental knowledge of risk reduction and risk management. They know methods of risk modelling and are able to apply them.

Content

- Earthquake Hazards
  - Short introduction to seismology and seismometry (occurrence of tectonic earthquakes, types of seismic waves, magnitude, intensity, source physics)
  - Induced seismicity
  - Engineering seismology, Recurrence intervals, Gutenberg-Richter, PGA, PGV, spectral acceleration, hazard maps
  - Earthquake statistics
  - Liquefaction
- Tsunami Hazards
- Landslide Hazards
- Hazards from Sinkholes
- Volcanic Hazards
  - Short introduction to physical volcanology
  - Types of volcanic hazards
- The Concept of Risk, Damage and Loss
- Data Analysis and the use of GIS in Risk analysis
- Risk Modelling - Scenario Analysis
- Risk Reduction and Risk Management
- Analysis Feedback and Prospects in the Risk Modelling Industry

Workload

- 60 h: active attendance during lectures and exercises
- 90 h: review, preparation and weekly assignments
- 90 h: project work

Learning type
4060121 Geological Hazards and Risk (V2)
4060122 Übungen zu Geological Hazards and Risk (Ü2)

Literature
Literature will be provided by the lecturer.

M 4.10 Module: Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, graded [M-PHYS-101952]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-PHYS-103571	Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, Studienleistung	3 CR	Ritter
T-PHYS-103673	Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, exam	1 CR	Ritter

Competence Certificate
Bearbeitung von Übungsblättern, Präsentation eines eigenen Vortrags, Erstellung eines Skriptabschnitts, schriftliche Anfertigung einer Zusammenfassung des Vortrags, Halten eines Vortrags im Gelände

Prerequisites
siehe untergeordnete Teilleistung

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-101872 - Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, not graded must not have been started.

Competence Goal
Die Studierenden kennen unterschiedliche Methoden, um Vulkane geophysikalisch in der Tiefe zu erkunden. Insbesondere verfügen sie über ein fundiertes Wissen im Bereich der Bohrlochmethoden im vulkanischen Umfeld.

Die Studierenden verstehen die Geschichte des Vulkanismus in einem miozänen Vulkankomplex, können dessen Entstehung wiedergeben und einordnen und mit den Ergebnissen geophysikalischer Untersuchungen verknüpfen. Im Gelände können sie die Strukturen des miozänen Vulkankomplexes erkennen und mit den Ergebnissen der geophysikalischen Untersuchungen, insbesondere denen der Forschungsbohrungen am Vogelsberg sowie den in den Bohrungen durchgeführten Experimenten, analysieren und interpretieren.

Die Studierenden können sich in einfache Themen und Problemstellungen einarbeiten, diese überblicken, analysieren, interpretieren und bewerten. Sie sind in der Lage, fachbezogen zu argumentieren und über die Inhalte mit Kommilitonen zu diskutieren und ihren eigenen Standpunkt zu vertreten. Ebenso können sie den Standpunkt der anderen kritisch hinterfragen.

Content

- Methoden der geophysikalischen Tiefenerkundung an Vulkanen
- Physikalische Bohrlochmessungen am Vulkan
- Aufbau eines miozänen Vulkankomplexes
- Geotope im Vogelsberg

Module grade calculation
Die Modulnote wird durch die Note der Erfolgskontrolle anderer Art bestimmt.

Bewertet wird: Schriftliche Zusammenfassung des Vortrags.

Workload
120 h teilen sich wie folgt auf:

- Vorlesung in Karlsruhe zur Vorbereitung inkl. deren Vor- und Nachbereitung: 5 h
- Bearbeiten von Übungsblättern: 5 h
- Erstellen eines Skriptkapitels: 20 h
- In-Situ-Vorlesung im Vogelsberg; 40 h
- Vorbereitung eines Vortrags: 20 h
- Schriftliche Zusammenfassung des Vortrags: 30 h

M 4.11 Module: Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, not graded [M-PHYS-101872]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	pass/fail	Irregular	1 term	German	4	1

Mandatory			
T-PHYS-103571	Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, Studienleistung	3 CR	Ritter

Competence Certificate
Bearbeitung von Übungsblättern, Präsentation eines eigenen Vortrags, Erstellung eines Skriptabschnitts, schriftliche Anfertigung eines Reflexionsberichts

Prerequisites
siehe untergeordnete Teilleistung

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-101952 - Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, graded must not have been started.

Competence Goal
Die Studierenden kennen unterschiedliche Methoden, um Vulkane geophysikalisch in der Tiefe zu erkunden. Insbesondere verfügen sie über ein fundiertes Wissen im Bereich der Bohrlochmethoden im vulkanischen Umfeld.

Die Studierenden verstehen die Geschichte des Vulkanismus in einem miozänen Vulkankomplex, können dessen Entstehung wiedergeben und einordnen und mit den Ergebnissen geophysikalischer Untersuchungen verknüpfen. Im Gelände können sie die Strukturen des miozänen Vulkankomplexes erkennen und mit den Ergebnissen der geophysikalischen Untersuchungen, insbesondere denen der Forschungsbohrungen am Vogelsberg sowie den in den Bohrungen durchgeführten Experimenten, analysieren und interpretieren.

Die Studierenden sind in der Lage, fachliche Diskussionen mit Kommilitonen zu führen und deren Standpunkt kritisch zu hinterfragen.

Content

- Methoden der geophysikalischen Tiefenerkundung an Vulkanen
- Physikalische Bohrlochmessungen am Vulkan
- Aufbau eines miozänen Vulkankomplexes
- Geotope im Vogelsberg

Module grade calculation
Die Studienleistung ist unbenotet.

Workload
90 h teilen sich wie folgt auf:

- Vorlesung in Karlsruhe zur Vorbereitung inkl. deren Vor- und Nachbereitung: 5 h
- Bearbeiten von Übungsblättern: 5 h
- Erstellen eines Skriptkapitels: 20 h
- In-Situ-Vorlesung im Vogelsberg; 40 h
- Vorbereitung eines Vortrags: 20 h

M 4.12 Module: Geophysical Monitoring of Tunnel Constructions [M-PHYS-103141]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
1	pass/fail	Irregular	1 term	German	4	1

Mandatory			
T-PHYS-106248	Geophysical Monitoring of Tunnel Constructions, Prerequisite	1 CR	Bohlen

Competence Certificate
Schriftliche Anfertigung eines Reflexionsberichts

Prerequisites
keine

Competence Goal
Die Studierenden kennen geophysikalische Messmethoden, mit denen ein Tunnelbau überwacht werden kann. Sie können die seismischen Daten, die dabei an der Erdoberflächeoder im Tunnel aufgezeichnet werden, verstehen und interpretieren. Sie kennen DIN-Normen und können diese auf die Daten anwenden. Die Studierenden kennen Beispiele, in denen ein Tunnelbau mit geophysikalischen Methoden überwacht wurde. Sie wissen auch, wo die Grenzen geophysikalischer Überwachung im Tunnelbau liegen.

Content

- Grundlagen der geophysikalischen Überwachung beim Tunnelbau
- Ziele der Überwachung mit geophysikalschen Methoden
- DIN-Normen
- Seismische Überwachung während des Tunnelvortriebs und Interpretation der Daten
- Vorauserkundung mit seismischen Methoden
- Fallbeispiele: Gotthardbasistunnel, Tunnel der U-Strab in Karlsruhe, Tunnel beim Bau von S21

Module grade calculation
Die Studienleistung ist unbenotet.

Workload
30 h teilen sich wie folgt auf:

- 10 h Vorlesung am GPI zur Vorbereitung
- 10 h In-Situ-Vorlesung bei einem Hersteller von Tunnelbohrmaschinen
- 10 h In-Situ-Vorlesung in einem Tunnelbauprojekt

Learning type
In situ Vorlesung

Literature
Wird in der Vorlesung bekanntgegeben.

M 4.13 Module: Hazard and Risk Assessment of Mediterranean Volcanoes, graded [M-PHYS-101873]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-PHYS-103572	Hazard and Risk Assessment of Mediterranean Volcanoes, Prerequisite	4 CR	Ritter
T-PHYS-103674	Hazard and Risk Assessment of Mediterranean Volcanoes, exam	2 CR	Ritter

Competence Certificate
Prereqisite: participation in all lectures and practicals

Exam: Presentations

Prerequisites
Introduction to Volcanology (lecture in summer term)

Competence Goal
Students have gained general knowledge of tectonics and geodynamics of the Mediterranean. They understand how tectonics and the geodynamic situation in the region led to the development of current volcanism. They can name active volcanoes in the Mediterranean, understand their formation and evolution.

Students know and understand concepts and definitions of geohazard and risk related to volcanism in the Mediterranean, and are able to distinguish one from another. They can apply their knowledge to geophysical problems, and are able to assess hazard potential of Mediterranean volcanoes.

Students have gained knowledge in modelling volcanic ash dispersal and volcanic ballistic objects and can apply thier knowledge to Mediterranean volcanoes.

Students are able to plan a small seismic experiment at abn active volcano, discuss advantages and disadvantages of certain measuring configurations, install seismic stations in the field, convert the data recorded to common formats, analyze and interpret it.

Students are able to work on a given concrete problem in a self-organized and solution-oriented manner. They can survey, analyze, interpret and evaluate those questions, summarize their answers in a report and formulate their own questions. They are able to discuss scientific literature with fellow students and to represent their own point of view. They can also critically question the other's point of view. They are able to present their own work as talk and/or poster.

Content

- Geodynamics and volcanism of the Mediterranean
- Volcanic hazard and risk related to Mediterranean volcanoes
- Modelling volcanic ash dispersal and trajectories of volcanic ballistic objects
- Seismic instrumentation at volcanoes
- Set-up of seismic instruments in different confgurations
- Seismic data analysis
- Presentation of talk and poster

Module grade calculation
Presentation in the field including discussion (30%) and poster presentation after in situ lecture (70%) will be graded. A detailed rating scheme will be distributed during the first lecture.

Workload
180 hours which comprise the following:

- Lectures at GPI before in situ: 6 h
- Practicals at GPI before in situ: 8 h
- Practicals at GPI after in situ: 12 h
- Preparation of a presentation held during in situ (in groups of 2): 16 h
- Preparation of a poster and presentation after in situ: 42 h
- In situ lecture (12 days): 96 h

Learning type
Classroom lecture, in situ lecture, practicals, computer exercises, presentations

Literature
Will be announced during the first lecture.

M 4.14 Module: Historical Seismology for Hazard Evaluation [M-PHYS-101961]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
1	pass/fail	Irregular	1 term	German	4	1

Mandatory			
T-PHYS-103679	Historical Seismology for Hazard Evaluation, Prerequisite	1 CR	Ritter

Competence Certificate
Schriftliche Anfertigung eines Reflexionsberichts, der auch Informationen zum Vortrag enthält.

Prerequisites
keine

Competence Goal
Die Studierenden kennen grundlegende Konzepte der Seismologie und deren historischen Anfänge. Sie wissen um die Bedeutung der seismischen Gefährdungsabschätzung und verfügen über die Kompetenz, die historische Seismologie in Bezug zur seismischen Gefährdungsabschätzung einzuordnen. Sie kennen seismische Messgeräte und deren historische Entwicklung, verstehen die physikalischen Prinzipien, auf denen die Messungen beruhen und deren theoretischen Grundlagen. Sie verstehen bedeutende seismologische Beiträge und Entdeckungen.

Die Studierenden sind in der Lage, wichtige Informationen zu einem historischen Erdbeben und einfache, empfohlene Fachliteratur zu verstehen, wiederzugeben und zu bewerten. Sie können einfache fachbezogene Inhalte mit den Kommilitonen diskutieren und ihren eigenen Standpunkt vertreten. Ebenso können sie den Standpunkt der anderen kritisch hinterfragen. Sie können die Inhalte schriftlich zusammenfassen, dabei reflektieren und einordnen.

Content

- Einführung in die Seismologie
- Anfänge der Seismologie
- Historische bedeutende Erdbeben
- Bedeutung historischer seismologischer Belege für Gefährdungsabschätzung
- Entwicklung seismischer Messgeräte und deren theoretische Grundlagen
- Bedeutende seismologische Beiträge und Entdeckungen

Module grade calculation
Die Studienleistung ist unbenotet.

Workload
30 h teilen sich auf in

- 9 h Vorlesung am KIT zur Vorbereitung inkl. studentischer Vorträge
- 7 h Vorbereitung des eigenen Vortrags
- 10 h In-Situ-Vorlesung im Oberrheingraben
- 4 h Erstellen eines schriftlichen Berichts

Learning type
In situ Vorlesung (eintägig) mit vorgeschaltetem Vorlesungsangebot am KIT

Literature
Wird in der Vorlesung bekanntgegeben.

M 4.15 Module: Induced Seismicity, graded [M-PHYS-101959]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
5	Grade to a tenth	Irregular	1 term	English	4	2

Mandatory			
T-PHYS-103575	Induced Seismicity, Studienleistung	3 CR	Ritter
T-PHYS-103677	Induced Seismicity, exam	2 CR	Ritter

Competence Certificate
Presentation (45%), report (45%) and participation in discussion (10%) will be graded. A detailed rating scheme will be distributed during the first lecture. Details about the length of the report and its rating will also be distributed.

Competence Goal
The students understand physical and tectonic causes and effects of induced seismicity, and they are able to explain its occurrence. They have gained basic knowledge of legal aspects associated with induced seismicity. They are able to distinguish between different physical sources of induced seismicity and can analyse seismicity caused by the loading of dams, due to mining, and associated with geothermal energy exploitation. The students know and are able to name regions, where induced seismicity occurs and can identify structures that may indicate the possible occurrence of induced seismicity in the field.
The students are able to work self-organized on a specific issue of induced seismicity. They are able to read and understand technical literature about the topic. They can outline and analyse the problem, and they are able to critically discuss the content of technical literature with their peers and present their own point of view. They can summarise the problem, and interpret and evaluate the content of technical literature on the topic of induced seismicity.

Content

- Fundamentals of Induced Seismicity
- Cause and Effect of Induced Seismicity
- Legal Aspects
- Case Studies: Dams, Mining, Geothermal Energy
- Field Trips to a Geothermal Energy Plant, to a Mining Region in Germany and to a dam

Module grade calculation
Presentation (45%), report (45%) and participation in discussion (10%) will be graded. A detailed rating scheme will be distributed during the first lecture.

Workload
Total workload: 150 h which consists of

- 10 h lecture at KIT as preparation
- 5 h preparation and wrap-up of lecture
- 40 h in situ lecture in Thuringia
- 35 h preparation of presentation
- 60 h preparation of report

M 4.16 Module: In-Situ: Summer School Bandung: Seismology/Geohazards [M-PHYS-104196]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-108691	In-Situ: Summer School Bandung: Seismology/Geohazards	6 CR	Rietbrock

Competence Certificate
The students receive a scientific paper to discuss in an international group of students regarding one of the above topics. They give a presentation about the paper (20 minutes plus 10 minutes of discussion) and write a summary (5-10 pages). The summary has to be handed in individually by every student two weeks after the end of the summer school and will be graded.

Prerequisites
none

Competence Goal
The students know about the geology and tectonics of Indonesia and surrounding regions. They understand the processes and stress distributions that led to the formation of the Indonesian archipelago and know methods to model those.

The students can explain how earthquakes sources are represented and know about the distribution and characteristics of earthquakes. They understand the concept of seismic sources and stresses and can explain basic concepts of earthquake geology. They are familiar with seismic data acquisition systems and seismic array techniques. They understand the idea behind seismic tomography methods and know applications on global as well as regional and local scale.

The students understand the concepts of physical volcanology and can name the processes that are responsible for volcanic hazard and risk. They know methods of volcano seismology, can explain several modeling techniques and know about monitoring volcanoes at observatories using different geophysical techniques.

The students know about tsunami and flooding hazard and understand basic concepts of disaster management. The students understand basic concepts of geothermal energy and its exploitation.

Content
Geology and Tectonics

- Geological Setting of Indonesia
- Visit to the Geological Museum, Bandung
- Introduction to Stress Modeling in Active Tectonic

Seismology, Seismic Hazard

- Introduction to Geohazards: Earthquake Hazard and Risk
- Distribution and Characteristic of Earthquakes
- Seismic sources and stresses
- Earthquake Geology
- Data acquisition and arrays
- Seismic Travel Time Tomography: Regional and Global Scale
- Local Earthquake Tomography
- Passive and active seismic imaging by seismic wave propagation modeling

Volcanology, Volcanic Hazard

- Physical Volcanology
- Volcanic hazard risk and assessment
- Volcano Seismology
- Modeling of Volcanic Products
- Visit of Guntur Volcano Observatory
- Visit to Tangkuban Parahu Volcano
- Visit to Center of Volcanology and Geological Hazard Mitigation

Tsunamis and Flooding Hazard

- Tsunamis: Generation, Inundation and Propagation
- Tsunamis: Hazard, Inundation and Warning
- Flood Hazard

Introduction to Disaster Management
Geothermal Systems

- Introduction to Geothermal system & Geology of Kamojang Field
- Visit of Kamojang

Module grade calculation
Students give a presentation (group work) about a scientific paper and write a report about it. The report is graded.

Workload
Total workload: 180 h, further details will be given in the lecture.

Learning type
4060351 - In-Situ: Summer School Seismology (Lecture)
4060352 - In-Situ: Summer School Seismology (Practicals)

Literature
Will be announced during the lecture.

M 4.17 Module: In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region [M-PHYS-106322]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: Electives (Usage from 4/1/2023)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	3	1

Mandatory			
T-PHYS-112830	In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region	6 CR	Rietbrock

Competence Certificate
Students solve exercise sheets, prepare and give a presentation and write a final report.

Competence Goal
Students understand the geodynamic and tectonic situation in the Mediterranean and especially in seismic active regions. They gain profound knowledge about seismic hazard, can explain the concept of seismic hazard assessment, and can apply it. They can name different monitoring methods, explain them and apply them under guidance.

Content

- Geodynamics of the Mediterranean
- Tectonics in Greece, Italy and the Balkans
- Seismic hazard, with focus on the Mediterranean
- Seismic monitoring
- Field work

Module grade calculation
The final mark is computed from all submissions.

Workload
180 h in total, composed of:

1. Lecture at KIT before in-situ part: 15 h
2. Data analysis at KIT: 5 h
3. Preparation of presentation and handout: 30 h
4. In-situ lecture: 80 h
5. Wrap-up of lectures, solving exercise sheets and preparation of report: 50 h

Learning type
4060351 (In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region),

4060352 (Exercises on In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region).

Literature
Will be announced during the lecture.

M 4.18 Module: Interdisciplinary Qualifications [M-PHYS-102349]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Interdisciplinary Qualifications

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Each term	2 terms	German	4	1

Elective Studies (Election: at least 1 item as well as at least 4 credits)			
T-PHYS-104675	Wildcard	2 CR	
T-PHYS-104677	Wildcard	2 CR	

Annotation
The module is ungraded. Should single courses within this module be graded, will those grades not count for the final master's average grade. The grade of those courses will however be shown in the transcript of records.

M 4.19 Module: International Workshop on Current Geophysical Research Topics [M-PHYS-105383]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
2	pass/fail	Irregular	1 term	English	4	2

Mandatory			
T-PHYS-110871	International Workshop on Current Geophysical Research Topics	2 CR	Rietbrock

Competence Certificate
The module is not graded. In ordert to pass the module, active participation in the workshop including an oral presentation is mandatory

Prerequisites
none

Competence Goal
Students can present their own research and critically discuss and defend their results. They know how to discuss current research topics presented by fellow students and international participants in the workshop.

Content
Overview about current geophysical research topics

Workload
2 ECTS in total, corresponding to 60 working hours, composed of active time (15 h) and preparation (45 h)

Learning type
Scientific presentation and discussion

Literature
none

M 4.20 Module: Introduction to Scientific Practice (GEOP M EWA) [M-PHYS-101361]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: Introduction to Scientific Practice

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
16	pass/fail	Each term	1 term	English	4	2

Mandatory			
T-PHYS-103355	Introduction to Research in a Scientific Sub-Field Including a Seminar Paper	16 CR	

Competence Goal
The students are familiarized with the topic of their master thesis. They acquired key qualifications in an integrative manner and are able to implement them. The students know basic working methods that are required for successful scientific research and are able to apply them on the basis of a specific task (topic of the master thesis).

Content

- goal-oriented work
- measurement technology
- protocol management
- teamwork
- study of literature
- formulation of scientific questions
- defense of own work results

Module grade calculation
The module is not graded.

Workload
The students submit a written report (synopsis) on the topic of their future master thesis, which shows that they have adopted the scientific working methods and the task of their work. Total workload: 480 h.

Learning type
4061909 Einführung in die selbständige wissenschaftliche Arbeit

Literature
Task-specific, literature provided by the supervisor

M 4.21 Module: Introduction to Volcanology, graded [M-PHYS-101866]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each summer term	1 term	English	2	2

Mandatory			
T-PHYS-103553	Introduction to Volcanology, Prerequisite	3 CR	Bohlen
T-PHYS-103644	Introduction to Volcanology, Exam	1 CR	Bohlen

Competence Certificate
Prerequisite (3 ECTS): Active and regular attendance of lecture and practicals, preparation and follow-up of lectures (at home), assignments, presentation of a volcano in a short (10 – 15 minute) talk with slides. Examination (1 ECTS): Scientific essay about the given presentation, approx. 8-10 pages, submitted electronically. The grade of the module results from grade of of the scientific essay.

Competence Goal
The Students know and understand the basic concepts of physical volcanology. They are able to classify volcanoes by their tectonic location, can discriminate between different eruption types and describe different volcanic edifices with respect to their tectonic environment. They understand the concept of volcanic hazard and risk and are able to apply it. They can explain the physics of volcanic monitoring methods and know about their advantages and disadvantages. They gained insight into numerical modelling tools and can name several appliations. The students understand the impact of volcanic eruptions on climate and know both, presently as well as historically active volcanoes and their prominent eruptions.

The students have gained an overview about active volcanoes and recent eruptions and are able to summerize the main characteristics and scientific achievements about one volcano of their choice in a 10-15 minute talk. They are able to discuss and answer questions related to their subject. They can summarize their research about the volcano of their choice in a scientific essay (8-10 pages).

Content

- Introduction, Overview
- Volcanoes and Plate Tectonics
- Magma and Volcanic Deposits
- Eruption types
- Volcanic Edifices
- Volcanic Hazard and Risk
- Volcano Monitoring
- Volcano Seismology
- Numerical Modelling of Volcanic Products
- Historic Eruptions
- Volcanoes and Climate

Module grade calculation
The grade of the module results from grade of of the scientific essay.

Annotation
Will not be offered in summer semester 2022.

Workload
28 h: Attendance, active participation in lectures and practicals

14 h: Preparation and follow-up of lectures (at home)

18 h: Homework, assignments

30 h: Preparation of presentation

30 h: Scientific essay about given presentation, submitted electronically

Learning type
4060251 Introduction to Volcanology (V1)
4060252 Exercises to Introduction to Volcanology (Ü1)

Literature
Literature will be provided by the lecturer.

M 4.22 Module: Modern Physics Laboratory Course [M-PHYS-101355]

Responsible: Studiendekan Physik
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	pass/fail	Each term	1 term	German	4	1

Mandatory			
T-PHYS-102291	Modern Physics Laboratory Courses	6 CR	Naber

Prerequisites
Classical Physics Laboratory Courses I and II

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-101353 - Classical Physics Laboratory Course I must have been passed.
2. The module M-PHYS-101354 - Classical Physics Laboratory Course II must have been passed.

Module grade calculation
The lab course is not graded.

M 4.23 Module: Modul Master's Thesis [M-PHYS-101730]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Master's Thesis

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
30	Grade to a tenth	Each term	1 term	English	4	2

Mandatory			
T-PHYS-103350	Master's Thesis	30 CR	Bohlen

Competence Certificate
Successful completion of the master's thesis and successful defense during a public colloqium.

Prerequisites
The modules 'Scientific Focusing Phase', 'Introduction to Scientific Practice', and 'Scientific Seminars' must be passed.

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-101360 - Scientific Focusing Phase must have been passed.
2. The module M-PHYS-101361 - Introduction to Scientific Practice must have been passed.
3. The module M-PHYS-101357 - Scientific Seminars must have been passed.

Competence Goal
The students are able to work independently on a scientific topic, guided by an experienced supervisor. They analyze problems, develop suitable solutions, interpret and assess results, and communicate those results and findings in writing in a clear and concise way in English. Furthermore, by presenting and defending the work in a public colloquium the students constructively interact with fellow scientists as part of a scientific exchange. Students know and apply the Guidelines for Safeguarding: Good Research Practice (Deutsche Forschungsgemeinschaft).

Content

- Independent but supervised work on the topic of the master's thesis
- Public colloquium open to all members of the faculty (no more than six weeks after finalizing the master's thesis)

Annotation
The module “Master Thesis” is preceded by the module “Scientific Focusing Phase” and the module “Introduction to Scientific Practice”, which has a total duration of 6 months. Registration for the module “Scientific Focusing Phase” should be **no later than three months after the last course exam**. The third and fourth terms of the master’s program form a closely linked unit. At the time of the changeover from the second to the third term, the students should seek a topic for a master thesis. This topic will be set at the beginning of the “Scientific Focusing Phase”. The master thesis aims to show that the student is able to work on a subject independently and in a limited time according to scientific methods that correspond to the current state of research. This usually requires a thorough introduction to the scientific field of the master thesis and the learning of specific, scientific tools and methods. Since the duration of the master thesis is only six months, the modules “Scientific Focusing Phase” and “Introduction to Scientific Practice” in the third term are used by the student to familiarize himself/herself with the topic of the master thesis. Thus, at the beginning of the fourth term a “flying start” in the actual master thesis is possible. Altogether, exactly 12 months are available for work in the specific field of the master thesis.

Process

1. Before the beginning of the “Scientific Focusing Phase”, the student chooses a topic for a master thesis. For this he talks to the heads of the research areas at the Geophysical Institute and/or attends the seminars of the research areas.
2. Once the topic of the master thesis has been agreed on, students will register online for exams in the modules “Scientific Focusing Phase” and “Introduction to Scientific Practice”.
3. The student then visits the Examination Office of the Faculty of Physics. There the prerequisites for the Master’s thesis will be checked and he/she will receive a registration form for the topic of the master thesis.
4. The student passes the form to the supervisor/ reviewer of the Master’s thesis. In mutual agreement they fill in the fields ’Referent’ (supervisor/ reviewer), ’Korreferent’ (co-supervisor/ co-reviewer), ’Vorläufiges Thema der Arbeit’ (preliminary subject), and ’Beginn der Arbeit’ (start date). The principal reviewer signs the form and returns it to the Examination Office where the respective entry for the Master’s thesis will be created in the online system. The deadline for the thesis will then be available to the student through the online system.
5. The student can only return the topic of the master thesis once and only within the first month (Study and Examination Regulations 14 [6]). If he/she makes use of it, he/she informs the supervisor and the reviewers. The principal reviewer informs the Examination Office and resigns the student from the examination of the “Scientific Focusing Phase”. The student starts again at point 1.
6. Six months after the registration of the topic of the master thesis, the student performs the examination in the module “Scientific Focusing Phase” (lecture) and in the module “Introduction to Scientific Practice” (written report). The main reviewer records the grade in the electronic examination system.

Submission of master thesis

No later than twelve months after registration for the module “Scientific Focusing Phase” or the date of submission indicated on the registration form, the thesis must be submitted to the Examination Office of the Faculty of Physics. The title page must contain the English and German title.

Workload
Total workload: 900 h.

Literature
Topic-specific, literature provided by the supervisor of the master's thesis

M 4.24 Module: Module Wildcard Electives [M-PHYS-103142]

Organisation: University
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
16	Grade to a tenth	Each term	1 term	German	4	2

Wildcard (Election: at least 1 item as well as between 2 and 16 credits)			
T-PHYS-106249	Wildcard	2 CR	
T-PHYS-106253	Wildcard	2 CR	

Prerequisites
None

M 4.25 Module: Near Surface Geophysical Prospecting [M-PHYS-101946]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
1	pass/fail	Irregular	1 term	German	4	1

Mandatory			
T-PHYS-103645	Near Surface Geophysical Prospecting, Prerequisite	1 CR	Ritter

Competence Certificate
Schriftliche Bearbeitung eines Übungsblatts inkl. Reflexionsbericht (unbenotet)

Competence Goal
Die Studierenden kennen geophysikalische Methoden zur Erkundung oberflächennaher Rohstoffe und verstehen die physikalischen Prinzipen dieser Methoden. Sie können die Methoden beschreiben, unterscheiden und kennen Anwendungen der Methoden. Insbesondere im Bereich der Erdwärme und der Erzerkundung kennen die Studierenden Fallbeispiele, die sie erörtern und deren Vorteile und Probleme sie benennen können. Im Gelände können die Studierenden Auswirkungen geophysikalischer Erkundung benennen und erläutern.

Die Studierenden sind in der Lage, einfache, empfohlene Fachliteratur zu verstehen, wiederzugeben und zu bewerten. Sie können einfache fachbezogene Inhalte mit den Kommilitonen diskutieren und ihren eigenen Standpunkt vertreten. Ebenso können sie den Standpunkt der anderen kritisch hinterfragen. Sie können die Inhalte schriftlich zusammenfassen, dabei reflektieren und einordnen.

Content

- Geophysikalischen Erkundungsmethoden oberflächennaher Rohstoffe
- Fallbeispiele Erdwärme und Erze

Module grade calculation
Die Studienleistung ist unbenotet.

Workload
6 h: Vorlesung (Einführungsveranstaltung) am GPI

7 h: In-Situ-Vorlesung im Gelände

17 h: Übungsblatt, Projektarbeit, Nachbereitung

Learning type
In-Situ-Lehrveranstaltung, bestehend aus Vorlesung am GPI, In-Situ-Abschnitt, Nachbereitung (Eigenstudium)

Literature
Wird in der Vorlesung bekannt gegeben.

M 4.26 Module: Near-surface seismic and GPR [M-PHYS-103855]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	pass/fail	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-107793	Near-surface seismic and GPR	6 CR	Bohlen, Pan

Competence Certificate
Final pass based on successful participation of the exercises.

Prerequisites
None

Competence Goal
The students know the fundamentals about wave propagation phenomena near the Earth's surface and near-surface investigations for both seismic and electromagnetic waves. They comprehend the wave composition of shallow seismic wavefields and the dispersion and multimodal characteristics of surface waves. The students understand the multichannel analysis of surface waves method and the properties of dispersion curves, how to image surface-wave dispersion curves from active-source and passive-source seismic data, and how to estimate near-surface S-wave velocity and Q-factor structures by solving inverse problems. They know and can describe the elastic-wave equations, dispersion equations, the Radon transform, least-square optimization methods, seismic interferometry, and the spatial autocorrelation method. Finally, students are able to process shallow-seismic field data and use analysis methods to solve simple near-surface geophysical and geotechnical problems.

Content

- Designing shallow-seismic acquisition systems
- Imaging, forward-calculation and inversion of surface-wave dispersion curves
- Multimodal characteristics of surface waves
- Inversion of surface-wave attenuation coefficients for quality factors
- Passive-source shallow seismic methods
- Marine surface-wave method
- Full-waveform inversion of shallow seismic data
- GPR method

Module grade calculation
The coursework is not graded.

Workload
180 hours composed of active time (45 h), wrap-up of the lectures and solving the exercises (135 h).

Recommendation
No explicit requirements. However, basic knowledge of seismic methods, wave propagation phenomena, and signal processing is essential.

Literature
Final pass based on successful participation of the exercises.

M 4.27 Module: Observatory Course [M-PHYS-105662]

Responsible: Dr. Thomas Forbriger
Organisation: KIT Department of Physics
Part of: Electives (Usage from 4/1/2021)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	pass/fail	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-111311	Observatory Course	3 CR	Forbriger

Competence Certificate
Processing and evaluation of selected introductory problems in a supervised self-study phase and active participation in experiments with subsequent data analysis at the BFO followed by a reporting effort are mandatory.

Prerequisites
One of the courseworks:

T-PHYS-102325 - Physics of Seismic Instruments, Prerequisite (MSc Geophysics)

T-PHYS-104727 - Physics of Seismic Instruments (MSc Physics)

T-PHYS-105567 - Physics of Seismic Instruments (NF) (MSc Physics)

Modeled Conditions
You have to fulfill one of 3 conditions:

1. The course T-PHYS-104727 - Physics of Seismic Instruments must have been passed.
2. The course T-PHYS-105567 - Physics of Seismic Instruments (Minor) must have been passed.
3. The course T-PHYS-102325 - Physics of Seismic Instruments, Prerequisite must have been passed.

Competence Goal
The students are able to define criteria for instrument performance in a research context. They are able to appropriately handle delicate instruments and to deploy them in an observatory environment. The students are able to assess data quality and to apply elementary measures of signal analysis to this end. The students are aware of appropriate means to mitigate disturbances. They are able to apply appropriate measures to improve data quality if needed. The students understand methods to calibrate the instruments frequency response and gain. They are able to design, carry out and analyze respective experiments. Students are able to express their results in a written report, to give appropriate feedback in a review process, and to incorporate received advice in a revision of their manuscripts.

Content

- Computational and practical application of knowledge gained in the course on 'Physics of seismic instruments.'
- Consolidation in topics that arose during the self-study phase.
- In-situ experiments with force-balance feedback broad-band seismometers
- Installation and calibration of instruments
- Quantitative data analysis, comparison with observatory recordings, and data quality assessment
- Signal processing in python

Module grade calculation
The coursework is not graded.

Annotation
Basic knowledge of python coding is essential. The course is usually arranged by appointment with participants of 'Physics of Seismic Instruments' during the winter term.

Workload
The course will be composed of an introductory guided self-study phase (2-3 weeks) followed by a practical phase held on three entire days at the Black Forest Observatory. The timely demand is roughly divided into: 45 hours self-study phase, 30 hours at BFO, 15 hours reporting

Learning type
4060914 Observatory course, Praktikum

Literature

- Bormann, P., (ed.), 2012. New Manual of Seismological Observatory Practice.
  2nd edition. GeoForschungsZentrum Potsdam. DOI: 10.2312/GFZ.NMSOP-2.
  http://dx.doi.org/10.2312/GFZ.NMSOP-2
  Chapter 5, information sheets and exercises on seismometer calibration
  in particular.
- Hutt, Charles R., Evans, John R., Followill, Fred, Nigbor, Robert L., and Wielandt, Erhard, 2010, Guidelines for standardized testing of broadband seismometers and accelerometers: U.S. Geological Survey Open-File Report, 2009-1295, 62 p. http://dx.doi.org/10.3133/ofr20091295

M 4.28 Module: Physical Methods in Volcano Seismology [M-PHYS-105679]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Electives (Usage from 4/1/2021)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Each summer term	1 term	English	4	1

Mandatory			
T-PHYS-111334	Physical Methods in Volcano Seismology	6 CR	Bohlen

Competence Certificate
Students have to participate the lecture/exercise regularly, and present their exercises/ project work. The presentation(s) will determine the final grade.

Prerequisites
None.

Competence Goal
The students understand seismological methods that are applied and commonly used in physical volcanology: They can name seismic instruments used for recording seismic data at volcanoes as well as advantages and disadvantages of different instruments. They know how to set up a seismic experiment at a volcano and understand the importance of a careful station site selection, but can also name limitations. They know how to access the data recorded, how to analyse and interpret it. They can distinguish different types of seismic signals typically recorded at volcanoes and know models to explain those. They can summarize their analysis, are able to present it to other students and discuss their results and those of their fellow students critically.

Content

- Seismic instrumentation at volcanoes
- Station site selection
- Analysis of seismic data recorded at volcanoes
- Interpretation of different seismic signals typically recorded at volcanoes
- Presentation of data and results,
- Discussion of physical models

Module grade calculation
Exercises/ project work will be graded.

Workload
180 h hours composed of contact time (45 h), preparation and wrap-up of the lectures and exercises (45 h), and exercises/ project work (90 h).

Recommendation
No explicit requirements. However, knowledge of the topics of physical volcanology and basics of data processing as well as general computer/ programming skills are essential.

Learning type
4060381 Physical Methods in Volcano Seismology, V1

4060382 Exercises to Physical Methods in Volcano Seismology, Ü2

M 4.29 Module: Physics of the Lithosphere, graded [M-PHYS-101960]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
3	Grade to a tenth	Irregular	1 term	German	4	1

Mandatory			
T-PHYS-103574	Physics of the Lithosphere, Studienleistung	2 CR	Ritter
T-PHYS-103678	Physics of the Lithosphere, exam	1 CR	Ritter

Competence Certificate
Die Modulnote wird durch die Note der Erfolgskontrolle anderer Art bestimmt. Benotet werden Übungsblätter (25%), Vortrag (25%) und Bericht (50%).

Prerequisites
keine

Competence Goal
Die Studierenden kennen den Aufbau und die physikalischen Eigenschaften der Lithosphäre und verstehen die unterschiedlichen Definitionen zur Lage der Lithosphären-Asthenosphären-Grenze. Sie verfügen über grundlegendes Wissen im Bereich der Gesteinsphysik, speziell über die mathematischen und physikalischen Gesetze der Spannungen in Gesteinen und können diese auf unbekannte Problemstellungen anwenden. Sie verstehen die physikalischen Konzepte von Elastizität, Biegesteifigkeit und Wärmefluss der Lithosphäre und können einfache Berechnungen mit gesteinsphysikalischen Parametern durchführen. Die Studierenden können ihre Ergebnisse analysieren und interpretieren.

Die Studierenden kennen physikalische Untersuchungsmöglichkeiten der Lithosphäre, insbesondere jene, welche an der Kontinentalen Tiefbohrung durchgeführt wurden. Sie können lithosphärische Gesteine im Gelände beschreiben, erkennen, einordnen und deren Entstehungsgeschichte erläutern. Sie reflektieren die neuen Kenntnisse kritisch und ordnen sie in einen größeren Zusammenhang ein.

Die Studierenden sind in der Lage, selbstorganisiert und lösungsorientiert an einer vorgegebenen konkreten Fragestellung aus dem Bereich der physikalischen Untersuchungsmethoden der Lithosphäre zu arbeiten und Fachliteratur zu verstehen. Sie können die Fragestellung überblicken, analysieren, interpretieren und bewerten. Sie sind in der Lage, fachbezogen zu argumentieren und über die Inhalte mit Kommilitonen zu diskutieren und ihren eigenen Standpunkt zu vertreten. Ebenso können sie den Standpunkt der anderen kritisch hinterfragen.

Content

- Aufbau und physikalische Eigenschaften der Lithosphäre
- Abgrenzung der Lithosphäre: Definitionen
- Gesteinsphysik
- Spannungen im Gestein
- Elastizität und Biegesteifigkeit
- Wärmefluss
- Physikalische Untersuchungsmethoden der Lithosphäre

Module grade calculation
Die Modulnote wird durch die Note der Erfolgskontrolle anderer Art bestimmt. Benotet werden Übungsblätter (25%), Vortrag (25%) und Bericht (50%).

Workload
90 h teilen sich auf in

- 15 h Vorlesung und Übungen am GPI
- 5 h Nachbereitung der Vorlesung und Übugen am GPI
- 18 h Vorlesung und Übungen im Gelände (In-Situ)
- 15 h Bearbeitung der Übungsblätter
- 25 h Vorbereitung des Vortrags
- 12 h Erstellen eines Berichts

M 4.30 Module: Recent Geodynamics (GEOD-MPGF-1) [M-BGU-101030]

Responsible: Dr. Malte Westerhaus
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German/English	4	2

Mandatory			
T-BGU-101772	Recent Geodynamics, Prerequisite *This item will not influence the grade calculation of this parent.*	1 CR	Westerhaus
T-BGU-101771	Recent Geodynamics	3 CR	Westerhaus

Competence Certificate

- T-BGU-101772 Rezente Geodynamik, Vorleistung
- T-BGU-101771 Rezente Geodynamik

For details on the assessments to be performed, see the details for the individual Teilleistungen.

Prerequisites
The modul M-BGU-101098 - Recent Geodynamics must not have stated.

Competence Goal
Students describe active deformation processes of the 'rigid' earth as a prominent source of changes in the earth system. They explain the special demands on measurement techniques and methods in Geodynamics from theory. The session is complemented by a visit at the Black Forest Observatory (BFO) where they gain an impression of the practical aspects of precise long term data recording. The students analyze the interrelation between observations and driving forces based on current research questions. Due to the interdisciplinary approach students discussdiscipline-specific paradigms. In the exercises the students use real data examples to model system response functions as well as source signals, and they assess the results. They are able to apply the imparted concepts to related problems and to transfer the learned knowledge to other research topics.

Content
The module provides the students with a profound insight into active deformation processes of the earth. The selected themes (measurement techniques, earth tides, free modes of the earth's rotational axis, plate tectonics, deformation of continental margins, mechanism of earthquakes) are specifically targeted at students of Geodesy as well as Geophysics. The central purpose of the module is to establish a link between geodetic and geophysical concepts, i.e. to relate precise geodetic measurements to the driving forces in the subsurface. The theoretical concepts are flanked by practical exercises, e.g. (i) use of earth tidal signals to calibrate a superconducting gravimeter, and (ii) use of GNSS data to model earthquake ruptures and the seismic cycle. During a 1-day excursion to the Black Forest Observatory (BFO) the students obtain insight into the daily duties of a geodynamic observatory, and they have the possibility to discuss current research questions together with the scientific and technical staff members.

Module grade calculation
The grade of the module is the grade of the oral exam in T-BGU-101771 Rezente Geodynamik.

Annotation
Basics of Geophysics and Physical Geodesy are helpful

Workload
Total workload: 120 hours

Contact hours: 45 hours

- courses plus course-related examination

Self-study: 75 hours

- consolidation of subject by recapitulation of lectures
- processing of exercises
- consolidation of subject by use of references and by own inquiry
- preparations for exam

M 4.31 Module: Scientific Focusing Phase (GEOP M SP) [M-PHYS-101360]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Scientific Focusing Phase

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
10	pass/fail	Each term	1 term	English	4	3

Prerequisite Scientific Focusing Phase (Election: 1 item)			
T-PHYS-107675	Seminar on Recent Topics of Applied Geophysics	10 CR	Bohlen
T-PHYS-107676	Seminar on Recent Topics of General Geophysics	10 CR	Rietbrock
T-PHYS-110593	Seminar Seismological Analysis	10 CR	Ritter

Competence Certificate
Examination of other type, not graded.

The examination of other type can be repeated at any time. However, only one reexamination is permitted.

Oral presentation, scientific discussion of the task at hand and the outcome of the student's work, and critical assessment in the relevant workgroup seminar. Pass granted upon successful completion of the presentation/discussion.

Competence Goal
The students fully understand the task of their master thesis at hand and its scientific background. They know the principle approach how to address scientific questions and have gained detailed knowledge regarding their specific subject, supervised by a member of the relevant workgroup. Through active participation in scientific discussions and presenting their own results, students are able to present and to exchange scientific opinions and critically assess results. They understand the importance of feedback and know how to incorporate constructive feedback into their work and working procedures. Students know and apply the Guidelines for Safeguarding: Good Research Practice (Deutsche Forschungsgemeinschaft).

Content
The students work independently but supervised on a specific scientific task related to their upcoming master thesis.

- Independent but supervised work on a specific scientific task related to the upcoming master thesis
- Active participation in the relevant workgroup seminar

Module grade calculation
The module is not graded.

Workload
10 ECTS in total, corresponding to 300 working hours.

Learning type

- 4060234 Seminar on Applied Geophysics (S2)
- 4060274 Current Topics in Seismology and Hazard (S2)
- 4060244 Seminar Seismological Analysis (S2)

Literature
Task-specific, literature provided by the supervisor

M 4.32 Module: Scientific Seminars (GEOP M WS) [M-PHYS-101357]

Responsible: Dr. Thomas Forbriger
Organisation: KIT Department of Physics
Part of: Introduction to Scientific Practice

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Each term	1 term	English	4	3

Mandatory			
T-PHYS-102335	Scientific Seminars	4 CR	

Competence Certificate
To be successful the student has to properly document the attendance at 12 seminars.

Competence Goal
The students comprehend geoscientific and physical problems, concepts and methods in a broad context beyond the core curriculum. They are able to make reasonable links to existing knowledge when listening to seminar presentations on subjects outside their field of specialization. They are able to summarize the key messages of seminar presentations. The students are able to join a critical scientific discourse. They ask well thought and precise questions in the aim to clarify misapprehensions and to deepen their understanding of neighboring scientfic disciplines.

Content
The students attend at least 12 seminar presentations at the Geophysical Institute, the KIT Department of Physics, and institutes of neighboring disciplines in earth sciences, at their choice (lists of current seminars are provided in the corresponding ILIAS-course). They gain an overview of major current research topics in the fields of these seminars. This way they broaden their understanding beyond their area of specialization. The students listen carefully to the presentations and make notes stating significant points of the presented subject as well as questions to be asked. They critically assess the consistency of the presentation within itself and with their existing knowledge. In the discussion of the presentation they ask appropriate questions to clarify apparent inconsistency or fill gaps of missing information. After the seminar they discuss the contents and new information with fellow students and prepare a report including a short (5 to 10 lines) summary of the respective presentation. Further instructions are given in the corresponding ILIAS course.

Module grade calculation
The module is not graded.

Annotation
Students taking this module shall register for the ILIAS course 'Scientific Seminars (GEOP M WS) [M-PHYS-101357]' at 'Repository >> Organisationseinheiten >> Fakultät für Physik >> Geophysikalisches Institut'. Further instructions, up-to-date information, and material is provided there. This includes form sheets for the 'Seminar Report' and the 'List of Seminars' which are available for download.

Each student attends at least 12 seminar presentations at the geophysical institute, the faculty of physics, and institutes of neighbouring disciplines in earth sciences (additional seminars may be accepted if the student applies for this in advance). At each seminar the student takes notes on a form sheet (seminar report) which is provided for download (ILIAS course). The notes are not necessarily complete in terms of lecture notes. They can be rather a collection of dispersed notes, keywords, and sketches.

After the presentation, the discussion with the audience, and a debriefing with fellow students, the student prepares a report on the form sheet. The report shall be written in full, proper sentences in a comprehensible and pointed way. It consists of a brief summary of the seminar and the discussion and some comments regarding the style of the presentation. This shall reflect the students judgement regarding major issues of the presentation, consistency of content, and the way he used questions to clarify open issues in the discussion of the seminar. If the presentation was not comprehensible this shall be described appropriately in the summary.

The students fill in a list of seminars. A form sheet is provided for download (ILIAS course). After having attended 12 seminar presentations, they submit the list together with the corresponding reports to the examiner. The examinar checks the reports and invites the student for a short interview. This interview shall give evidence, that the student in fact attended all the listed seminars. After a successful discussion of the report sheets, the examinar keeps the signed list of seminars for documentation and returns the reports to the student.

Workload
Total workload: 120 h, further details will be given individually.

Learning type
see ILIAS course

Literature
Abstracts published in the seminar programs.

M 4.33 Module: Seismic Data Processing with Final Report (graded) [M-PHYS-104186]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	Grade to a tenth	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-108656	Seismic Data Processing, Final Report (graded)	4 CR	Bohlen, Hertweck
T-PHYS-108686	Seismic Data Processing, Coursework	2 CR	Bohlen, Hertweck

Competence Certificate
Students have to participate the lecture/exercise on a regular basis and give a final presentation about their processing results (2 ECTS points). Students who would like to get the full 6 ECTS points also need to prepare and hand in a seismic data processing report. The report will determine the final grade (if applicable).

Prerequisites
None

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-104188 - Seismic Data Processing with final report (ungraded) must not have been started.
2. The module M-PHYS-104189 - Seismic Data Processing without Final Report (Ungraded) must not have been started.

Competence Goal
The students have hands-on experience applying typical seismic processing and imaging techniques to reflection seismic field data. In this way, they understand the reflection seismic method and have practical skills in data analysis and problem solving which are beneficial in their professional life later on, not only in exploration. Students can set up a basic processing and imaging flow, understand the individual processing steps and their purpose, and describe the influence of important parameters on processing results. They are able to identify data shortcomings and imaging challenges and develop basic solutions, analyze the success of individual processing/imaging steps, and critically assess the overall quality of their work. Finally, students are able to present their processing results in oral and written form.

Content

- Field data loading, quality control, trace edits and geometry setup
- Spectral analysis, filter application, geometrical spreading correction
- Deconvolution, zero-phasing
- Denoising using various approaches
- Multiple identification and removal (SRME, Radon)
- CMP sort, velocity analysis, NMO correction, mute and stack
- Time migration (prestack and poststack)
- Post-migration processing
- Basic interpretation (in cooperation with KIT-AGW)
- Optional: depth velocity model building and depth migration

Module grade calculation
The report will determine the final grade.

Annotation
A commercial data processing software is used during this course.

Workload
180 h hours composed of contact time (45 h), wrap-up of the lectures and solving the exercises (135 h)

Recommendation
No explicit requirements. However, basic knowledge of the reflection seismic method and general computer skills are essential. This course does not require any programming skills.

Learning type
4060321 Th.Bohlen, Th. Hertweck (V1)

4060322 Th.Bohlen, Th. Hertweck (Ü2)

Literature

- Öz Yilmaz, "Seismic Data Analysis", 2001, Society of Exploration Geophysicists.
- Luc Ikelle and Lasse Amundsen, "Introduction to Petroleum Seismology", 2005, Society of Exploration Geophysicists.
- Robert Sheriff and Lloyd Geldart, "Exploration Seismology", 1995, Cambridge University Press.

M 4.34 Module: Seismic Data Processing with final report (ungraded) [M-PHYS-104188]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
6	pass/fail	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-108657	Seismic Data Processing, final report (ungraded)	4 CR	Bohlen, Hertweck
T-PHYS-108686	Seismic Data Processing, Coursework	2 CR	Bohlen, Hertweck

Competence Certificate
Students have to participate the lecture/exercise on a regular basis and give a final presentation about their processing results (2 ECTS points). Students who would like to get the full 6 ECTS points also need to prepare and hand in a seismic data processing report. The report will determine the final grade (if applicable).

Prerequisites
None

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-104186 - Seismic Data Processing with Final Report (graded) must not have been started.
2. The module M-PHYS-104189 - Seismic Data Processing without Final Report (Ungraded) must not have been started.

Competence Goal
The students have hands-on experience applying typical seismic processing and imaging techniques to reflection seismic field data. In this way, they understand the reflection seismic method and have practical skills in data analysis and problem solving which are beneficial in their professional life later on, not only in exploration. Students can set up a basic processing and imaging flow, understand the individual processing steps and their purpose, and describe the influence of important parameters on processing results. They are able to identify data shortcomings and imaging challenges and develop basic solutions, analyze the success of individual processing/imaging steps, and critically assess the overall quality of their work. Finally, students are able to present their processing results in oral and written form.

Content

- Field data loading, quality control, trace edits and geometry setup
- Spectral analysis, filter application, geometrical spreading correction
- Deconvolution, zero-phasing
- Denoising using various approaches
- Multiple identification and removal (SRME, Radon)
- CMP sort, velocity analysis, NMO correction, mute and stack
- Time migration (prestack and poststack)
- Post-migration processing
- Basic interpretation (in cooperation with KIT-AGW)
- Optional: depth velocity model building and depth migration

Module grade calculation
The coursework is not graded.

Annotation
A commercial data processing software is used during this course.

Workload
180 h hours composed of contact time (45 h), wrap-up of the lectures and solving the exercises (135 h)

Recommendation
No explicit requirements. However, basic knowledge of the reflection seismic method and general computer skills are essential. This course does not require any programming skills.

Learning type
4060321 Th.Bohlen, Th. Hertweck (V1)

4060322 Th.Bohlen, Th. Hertweck (Ü2)

Literature

- Öz Yilmaz, "Seismic Data Analysis", 2001, Society of Exploration Geophysicists.
- Luc Ikelle and Lasse Amundsen, "Introduction to Petroleum Seismology", 2005, Society of Exploration Geophysicists.
- Robert Sheriff and Lloyd Geldart, "Exploration Seismology", 1995, Cambridge University Press.

M 4.35 Module: Seismic Data Processing without Final Report (Ungraded) [M-PHYS-104189]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
2	pass/fail	Irregular	1 term	English	4	1

Mandatory			
T-PHYS-108686	Seismic Data Processing, Coursework	2 CR	Bohlen, Hertweck

Competence Certificate
Students have to participate the lecture/exercise on a regular basis and give a final presentation about their processing results (2 ECTS points). Students who would like to get the full 6 ECTS points also need to prepare and hand in a seismic data processing report. The report will determine the final grade (if applicable).

Prerequisites
None

Modeled Conditions
The following conditions have to be fulfilled:

1. The module M-PHYS-104186 - Seismic Data Processing with Final Report (graded) must not have been started.
2. The module M-PHYS-104188 - Seismic Data Processing with final report (ungraded) must not have been started.

Competence Goal
The students have hands-on experience applying typical seismic processing and imaging techniques to reflection seismic field data. In this way, they understand the reflection seismic method and have practical skills in data analysis and problem solving which are beneficial in their professional life later on, not only in exploration. Students can set up a basic processing and imaging flow, understand the individual processing steps and their purpose, and describe the influence of important parameters on processing results. They are able to identify data shortcomings and imaging challenges and develop basic solutions, analyze the success of individual processing/imaging steps, and critically assess the overall quality of their work. Finally, students are able to present their processing results in oral and written form.

Content

- Field data loading, quality control, trace edits and geometry setup
- Spectral analysis, filter application, geometrical spreading correction
- Deconvolution, zero-phasing
- Denoising using various approaches
- Multiple identification and removal (SRME, Radon)
- CMP sort, velocity analysis, NMO correction, mute and stack
- Time migration (prestack and poststack)
- Post-migration processing
- Basic interpretation (in cooperation with KIT-AGW)
- Optional: depth velocity model building and depth migration

Module grade calculation
The coursework is not graded.

Annotation
A commercial data processing software is used during this course.

Workload
60 h hours composed of contact time (45 h) and wrap-up of the lectures (15 h) - no final report

Recommendation
No explicit requirements. However, basic knowledge of the reflection seismic method and general computer skills are essential. This course does not require any programming skills.

Learning type
4060321 Th.Bohlen, Th. Hertweck (V1)

4060322 Th.Bohlen, Th. Hertweck (Ü2)

Literature

- Öz Yilmaz, "Seismic Data Analysis", 2001, Society of Exploration Geophysicists.
- Luc Ikelle and Lasse Amundsen, "Introduction to Petroleum Seismology", 2005, Society of Exploration Geophysicists.
- Robert Sheriff and Lloyd Geldart, "Exploration Seismology", 1995, Cambridge University Press.

M 4.36 Module: Seismometry, Signal Processing and Seismogram Analysis (GEOP M MSS) [M-PHYS-101358]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: Geophysics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
22	Grade to a tenth	Each winter term	1 term	English	4	3

Mandatory			
T-PHYS-102325	Physics of Seismic Instruments, Prerequisite	0 CR	Forbriger
T-PHYS-109267	Seismology, Prerequisite	0 CR	Rietbrock
T-PHYS-109266	Seismics, Prerequisite	0 CR	Bohlen
T-PHYS-106217	Seismometry, Signal Processing and Seismogram Analysis, Exam	22 CR	Bohlen, Rietbrock

Competence Certificate

General

To pass the module, the oral exam must be passed. As prerequisites the examinations of other type (of all three courses) must be passed.

The examination prerequisites are successful participation in 'Exercises of Physics of Seismic Instruments', 'Exercises of Seismology' and 'Exercises of Seismics'.

The oral exam with a duration of approximately 60 minutes covers the complete content of all exercises and lectures of the module comprehensively. The examinations of other type check the contents of the corresponding exercises.

In general, the examinations of other type can be repeated within 8 weeks, but at the latest within the period of one year. An oral reexamination usually takes place at the beginning of the next semester at the latest. A missed oral reexamination may be repeated once.

Physics of Seismic Instruments

In order to pass the course Physics of Seismic Instruments, a student must successfully participate in the corresponding exercise classes. Successful participation is based on exceeding a certain percentage of the combined total number of points awarded, as applicable, for exercise sheets, other homework (such as, for instance, reports) and written tests held as part of the exercises. The percentage threshold is communicated to students at the beginning of the course and documented in Ilias.

Seismology

In order to pass the course Seismology, a student must successfully participate in the corresponding exercise classes. Successful participation is based on exceeding a certain percentage of the combined total number of points awarded, as applicable, for exercise sheets, other homework (such as, for instance, reports) and written tests held as part of the exercises. The percentage threshold is communicated to students at the beginning of the course and documented in Ilias.

Seismics

In order to pass the course Seismics, a student must successfully participate in the corresponding exercise classes. Successful participation is based on exceeding a certain percentage of the combined total number of points awarded, as applicable, for exercise sheets, other homework (such as, for instance, reports) and written tests held as part of the exercises. The percentage threshold is communicated to students at the beginning of the course and documented in Ilias.

Competence Goal

Physics of Seismic Instruments

The students understand the causes and consequences of different physical excitation mechanisms for inertial seismometers. They can explain essential considerations for installation and shielding. The students understand the concept of frequency response and are able to express a transfer function in terms of poles and zeroes. They can apply these concepts to sensors with electrodynamic transducers. The students can explain the significance of linearity. They are able to quantitatively infer the physical input signal from the recording of a seismic instrument. The students are able to use the concepts of bandwidth and dynamic range when expressing properties of signals and instruments. The students know means to express noise levels and to estimate instrumental self-noise. They can explain measures to increase the sensitivity and can explain the essential principles of modern force-balance feedback seismometers.

Seismology

The students understand the fundamental concepts of seismology and the earthquake rupture process. They have a knowledge of seismogram interpretation, fundamentals of seismic wave propagation and the representations of the earthquake source. Students are able to apply their knowledge to observed data to gain an insight into the Earth structure and the earthquake source.

Seismics

The students know the fundamental concepts of seismic acquisition, processing and imaging in reflection seismics. They can correctly name equipment, tools and processes and effectively communicate with specialists in the field of seismics. Students understand the various steps involved in seismic processing/imaging, their underlying theory and how they affect the data. They are able to apply the concepts and equations to simple exemplary seismic data.

Content

Physics of Seismic Instruments

- The mechanical sensor and the driven harmonic oscillator
- Various driving forces and wanted and unwanted sensitivity
- Installation and shielding
- The seismometer with electrodynamic transducer, effective gain, and damping due to passive electrodynamic feedback
- The frequency response, transfer function, poles and zeroes, non-linearity
- Seismic signals, bandwidth, dynamic range, and noise floor
- The force-balance feedback seismometer, displacement transducer, phase sensitive rectifier, controller, and the role of open-loop gain
- Effective transfer function of the velocity broad-band seismometer

Seismology

- History of seismology
- Elasticity and seismic waves
- Body waves and surface waves
- Seismogram interpretation
- Earthquake location
- Determination of Earth structure
- Seismic sources
- Seismic moment tensor
- Earthquake kinematics and dynamics
- Seismotectonics

Seismics

- Overview of seismic methods and wave propagation basics
- Essential signal processing concepts and tools
- Seismic acquisition, sources and receivers, marine and land
- Geometries and traveltimes, NMO and DMO
- Processing steps: from data loading to denoise and demultiple
- Velocity analysis, NMO correction, stacking, SNR
- Imaging: basic concepts, time and depth migration, migration methods
- Seismic resolution
- Optional: advanced acquisition, processing and imaging technologies

Module grade calculation

The grade of the module results from the grade of the oral exam.

Workload
22 ECTS in total, corresponding to 660 working hours. For the specific courses:

- Physics of Seismic Instruments: 180 h, composed of active time (45 h), wrap-up of the lectures incl. preparation of the oral exam and solving the exercises (135 h)
- Seismology: 240 h, composed of active time (60 h), wrap-up of the lectures incl. preparation of the oral exam and solving the exercises (180 h)
- Seismics: 240 h, composed of active time (60 h), wrap-up of the lectures incl. preparation of the oral exam and solving the exercises (180 h)

Recommendation
Physics of Seismic Instruments

A sound knowledge of the theory of ordinary differential equations and integral transformations (Fourier transformation) is expected. Basic skills in pratical signal processing using elementary computer programming techniques are needed in the exercises. A basic understanding of seismic waves in the Earth is helpful.

Seismology

A sound knowledge of the fundamentals in Geophysics. Basic skills in programming and Python to solve exercises.

Seismics

Experience with Python/Matlab, the Linux commandline, and shell scripts is beneficial. Knowledge of fundamental signal processing theory is essential.

Learning type

- Physics of Seismic Instruments (V2 Ü1, 3 SWS, 6 ECTS, prerequisite for oral examination)
- Seismology (V2 Ü2, 4 SWS, 8 ECTS, prerequisite for oral examination)
- Seismics (V2 Ü2, 4 SWS, 8 ECTS , prerequisite for oral examination)

Literature
Physics of Seismic Instruments

- Bormann, P., (ed.), 2012. New Manual of Seismological Observatory Practice. 2nd edition. GeoForschungsZentrum Potsdam. DOI: 10.2312/GFZ.NMSOP-2. http://dx.doi.org/10.2312/GFZ.NMSOP-2. Chapters 4 and 5 in particular.

Further recommendations will be given during the course.

Seismology

- Peter M. Shearer, "Introduction to Seismology", Cambridge Uniersity Press.
- Thorne Lay and Terry C. Wallace, "Modern Global Seismology", Academic Press.
- Seth Stein and Michael Wysession, "An Introduction to Seismology, Earthquakes, and Earth Structure", Blackwell Publishing.

Seismics

- Öz Yilmaz, "Seismic Data Analysis", 2001, Society of Exploration Geophysicists.
- Luc Ikelle and Lasse Amundsen, "Introduction to Petroleum Seismology", 2005, Society of Exploration Geophysicists.
- Jon Claerbout, "Fundamentals of geophysical data processing", 1976, McGraw-Hill.
- Etienne Robein, "Seismic Imaging: A Review of the Techniques, their Principles, Merits and Limitations", 2010, European Association of Geoscientists and Engineers.

M 4.37 Module: Seminar on Recent Topics of Risk Science [M-PHYS-103803]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	pass/fail	Each winter term	1 term	English	4	2

Mandatory			
T-PHYS-107673	Seminar on Recent Topics of Risk Science	4 CR	Rietbrock

Competence Certificate
Preparation and presentation of several presentation(s) based on a scientific publication, critical discussion of the scientific results.

Prerequisites
None

Competence Goal
The students understand scientific literature regarding current topics of natural hazards and risk. They can summarize a selected topic, describe and explain the main idea to their fellow students in an oral presentation (30-40 minutes). They know how to structure and present a scientific talk. They are able to understand the topics presented by their fellow students, discuss and analyze the content critically. They are able to compare those research results and evaluate the content critically.

Content
The students will read and discuss current literature about current topics of natural hazards and risk.

Module grade calculation
The module is not graded.

Workload
Presence at seminar, dicussions, presentation of homework: 30 h

Preparation, reading (homework): 90 h

Learning type
4060254 Seminar über aktuelle Fragen aus der Risikoforschung (S2)

Literature
Will be announced during the seminar.

M 4.38 Module: Structural Geology and Tectonics [M-BGU-101996]

Responsible: apl. Prof. Dr. Agnes Kontny
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
4	Grade to a tenth	Each winter term	1 term	German	4	1

Mandatory			
T-BGU-103712	Structural Geology and Tectonics	4 CR	Kontny

Prerequisites
None

M 4.39 Module: Supplementary Studies on Culture and Society [M-ZAK-106235]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: Additional Examinations (Usage from 10/1/2022)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
22	Grade to a tenth	Each term	3 terms	German	3	1

Election notes
With the exception of the final oral exam and the practice module, students have to self-record the achievements obtained in the Supplementary Studies on Culture and Society in their study plan. 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 ZAK homepage at https://www.zak.kit.edu/begleitstudium-bak.php. The title of the examination and the amount of credits override the modules placeholders.

If you want to use ZAK achievements **both for your interdisciplinary qualifications and for the supplementary studies**, please record them in the interdisciplinary qualifications first. You can then get in contact with the ZAK study services (stg@zak.kit.edu) to also record them in your supplementary studies.

In the in-depth module, achievements have to be obtained in three different areas. The areas are as follows:

- Technology & Responsibility
- Doing Culture
- Media & Aesthetics
- Spheres of Life
- Global Cultures

You have to obtain two achievements with 3 credits each and one achievement with 5 credits. To self-record achievements in the in-depth module, you first have to elect the matching partial achievement.

Note: If you registered for the Supplementary Studies on Sustainable Development before April 1st, 2023, self-recording an achievement in this module counts as a request in the sense of §20 (2) of the regulations for the Supplementary Studies on Culture and Society. Your overall grade for the supplementary studies will thus be calculated as the average of the examantion grades, not as the average of the module grades.

Mandatory			
T-ZAK-112653	Basics Module - Self Assignment BAK	3 CR	Mielke, Myglas
In-depth Module (Election: 3 items)			
T-ZAK-112654	In-depth Module - Technology & Responsibility - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112655	In-depth Module - Doing Culture - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112656	In-depth Module - Media & Aesthetics - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112657	In-depth Module - Spheres of Life - Self Assignment BAK	3 CR	Mielke, Myglas
T-ZAK-112658	In-depth Module - Global Cultures - Self Assignment BAK	3 CR	Mielke, Myglas
Mandatory			
T-ZAK-112660	Practice Module	4 CR	Mielke, Myglas
T-ZAK-112659	Oral Exam - Supplementary Studies on Culture and Society	4 CR	Mielke, Myglas

Competence Certificate
The monitoring is explained in the respective partial achievement.

They are composed of:

- minutes
- presentations
- a seminar paper
- an internship report
- an oral examination

After successful completion of the supplementary studies, the graduates receive a graded certificate and a KIT certificate.

Prerequisites
The offer is study-accompanying and does not have to be completed within a defined period of time. Enrolment or acceptance for graduation must be present when registering for the final examination.

KIT students register for the supplementary studies by selecting this module in the student portal and self-checking a performance. In addition, registration for the individual courses is necessary, which is possible shortly before the beginning of each semester.

The course catalogue, statutes (study regulations), registration form for the oral exam, and guides for preparing the various written performance requirements can be found as downloads on the ZAK homepage at www.zak.kit.edu/begleitstudium-bak.

Competence Goal
Graduates of the Supplementary Studies on Culture and Society demonstrate a sound basic knowledge of conditions, procedures and concepts for analysing and shaping fundamental social development tasks in connection with cultural topics. They have gained a well-founded theoretical and practical insight into various cultural studies and interdisciplinary topics in the field of tension between culture, technology and society in the sense of an expanded concept of culture.

They are able to place the contents selected from the specialization module in the basic context as well as to analyse and evaluate the contents of the selected courses independently and exemplarily and to communicate about them scientifically in written and oral form. Graduates are able to analyse social topics and problem areas and critically reflect on them in a socially responsible and sustainable perspective.

Content
The Supplementary Studies on Culture and Society can be started from the 1st semester and is not limited in time. It comprises at least 3 semesters. The supplementary studies are divided into 3 modules (basics, in-depth studies, practice). A total of 22 credit points (ECTS) are earned.

The thematic elective areas of the supplementary studies are divided into the following 5 modules and their sub-topics:

Block 1Technology & Responsibility

Value change / ethics of responsibility, technology development / history of technology, general ecology, sustainability

Block 2Doing Culture

Cultural studies, cultural management, creative industries, cultural institutions, cultural policy

Block 3Media & Aesthetics

Media communication, cultural aesthetics

Block 4Spheres of Life

Cultural sociology, cultural heritage, architecture and urban planning, industrial science

Block 5Global Cultures

Multiculturalism / interculturalism / transculturalism, science and culture

Module grade calculation
The overall grade of the supplementary studies is calculated as an average of the grades of the examination performances weighted with credit points.

In-depth Module

- presentation 1 (3 ECTS)
- presentation 2 (3 ECTS)
- seminar paper incl. presentation (5 ECTS)
- oral examination (4 ECTS)

Annotation
With the Supplementary Studies on Culture and Society, KIT provides a multidisciplinary study offer as an additional qualification, with which the respective specialized study program is supplemented by interdisciplinary basic knowledge and interdisciplinary orientation knowledge in the field of cultural studies, which is becoming increasingly important for all professions.

Within the framework of the supplementary studies, students acquire in-depth knowledge of various cultural studies and interdisciplinary subject areas in the field of tension between culture, technology and society. In addition to high culture in the classical sense, other cultural practices, common values and norms as well as historical perspectives of cultural developments and influences are considered.

In the courses, conditions, procedures and concepts for the analysis and design of fundamental social development tasks are acquired on the basis of an expanded concept of culture. This includes everything created by humans - also opinions, ideas, religious or other beliefs. The aim is to develop a modern concept of cultural diversity. This includes the cultural dimension of education, science and communication as well as the preservation of cultural heritage. (UNESCO, 1982)

According to § 16 of the statutes, a reference and a certificate are issued by the ZAK for the supplementary studies. The achievements are also shown in the transcript of records of the degree program and, upon request, in the certificate. They can also be recognized in the interdisciplinary qualifications (see elective information).

Workload
The workload is made up of the recommended number of hours for the individual modules:

- basic module approx. 90 h
- in-depth module approx. 340 h
- practical module approx. 120 h

total: approx. 550 h

Learning type

- lectures
- seminars
- workshops
- practical course

Literature
Recommended reading of primary and specialized literature will be determined individually by each instructor.

M 4.40 Module: Supplementary Studies on Sustainable Development [M-ZAK-106099]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: Additional Examinations (Usage from 4/1/2023)

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
19	Grade to a tenth	Each term	3 terms	German	3	1

Election notes
With the exception of the final oral exam, students have to self-record the achievements obtained in the Supplementary Studies on Sustainable Development in their study plan. 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 ZAK homepage at https://www.zak.kit.edu/begleitstudium-bene. The title of the examination and the amount of credits override the modules placeholders.

If you want to use ZAK achievements **both for your interdisciplinary qualifications and for the supplementary studies**, please record them in the interdisciplinary qualifications first. You can then get in contact with the ZAK study services (stg@zak.kit.edu) to also record them in your supplementary studies.

In the elective module, you need to obtain 6 credits worth of achievements in two of the four areas:

- Sustainable Cities & Neighbourhoods
- Sustainable Assessment of Technology
- Subject, Body, Individual: The Other Side of Sustainability
- Sustainability in Culture, Economy & Society

Usually, two achievements with 3 credits each have to be obtained. To self-record achievements in the elective module, you first have to elect the matching partial achievement.

Note: If you registered for the Supplementary Studies on Sustainable Development before April 1st, 2023, self-recording an achievement in this module counts as a request in the sense of §19 (2) of the regulations for the Supplementary Studies on Sustainable Development. Your overall grade for the supplementary studies will thus be calculated as the average of the examantion grades, not as the average of the module grades.

Mandatory			
T-ZAK-112345	Basics Module - Self Assignment BeNe	3 CR	Myglas
Elective Module (Election: at least 6 credits)			
T-ZAK-112347	Elective Module - Sustainable Cities and Neighbourhoods - Self Assignment BeNe	3 CR	
T-ZAK-112348	Elective Module - Sustainability Assessment of Technology - Self Assignment BeNe	3 CR	
T-ZAK-112349	Elective Module - Subject, Body, Individual: the Other Side of Sustainability - Self Assignment BeNe	3 CR	
T-ZAK-112350	Elective Module - Sustainability in Culture, Economy and Society - Self Assignment BeNe	3 CR	
Mandatory			
T-ZAK-112346	Specialisation Module - Self Assignment BeNe	6 CR	Myglas
T-ZAK-112351	Oral Exam - Supplementary Studies on Sustainable Development	4 CR	

Competence Certificate
The monitoring is explained in the respective partial achievement .

They are composed of:

- protocols
- a reflection report
- presentations
- presentations
- the elaboration of a project work
- an individual term paper

Upon successful completion of the supplementary studies, graduates receive a graded report and a certificate issued by ZAK.

Prerequisites
The course is offered during the course of study and does not have to be completed within a defined period of time. Enrolment is required for all performance assessments of the modules of 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 self-booking a performance. Registration for courses, performance assessments and examinations is regulated by § 6 of the Statutes and is usually possible shortly before the beginning of the semester.

The course catalogue, statutes (study regulations), registration form for the oral exam and guidelines for preparing the various written performance requirements can be found as downloads on the ZAK homepage at http://www.zak.kit.edu/begleitstudium-bene.

Competence Goal
Graduates of the supplementary studies in sustainable development acquire additional practical and professional competencies. Thus, the supplementary study program enables the acquisition of basics and initial experience in project management, trains teamwork skills, presentation skills and self-reflection, and also creates a fundamental understanding of sustainability that is relevant for all professional fields.

Graduates are able to analyse social topics and problem areas and critically reflect on them in a socially responsible and sustainable perspective. They are able to place the contents selected from the modules "Elective" and "Advanced" in the basic context as well as to independently and exemplarily analyse and evaluate the contents of the selected courses and to scientifically communicate about them in written and oral form.

Content
The supplementary study program Sustainable Development can be started from the 1st semester and is not limited in time. The wide range of courses offered by ZAK makes it possible to complete the program usually within three semesters. The supplementary studies comprise 19 credit points (LP). It consists of three modules: Basic Module, Elective Module and Advanced Module.

The thematic elective areas of the supplementary studies are divided into the following 4 modules and their subtopics in Module 2 (elective module):

Block 1 **Sustainable Cities and Neighbourhoods**

The courses provide an overview of the interaction of social, ecological, and economic dynamics in the microcosm of the city.

Block 2 **Sustainability Assessment of Technology**

Mostly based on ongoing research activities, methods and approaches of technology assessment are elaborated.

Block 3 **Subject, Body, Individual: The other Side of Sustainability**

Different approaches are presented to the individual perception, experience, shaping and responsibility of relationships to the environment and to oneself.

Block 4 **Sustainability in Culture, Economy & Society**

Courses usually have an interdisciplinary approach, but may also focus on one of the areas of culture, economics or society, both in application and in theory.

The core of the supplementary studies is a case study in the specialization area. In this project seminar, students conduct sustainability research with practical relevance themselves. The case study is supplemented by an oral examination with two topics from module 2 (elective module) and module 3 (in-depth module).

Module grade calculation
The overall grade of the supplementary studies is calculated as an average of the grades of the examination performances weighted with credit points.

Elective module

- Presentation 1 (3 ECTS)
- Presentation 2 (3 ECTS)

Advanced module

- individual term paper (6 ECTS)
- oral examination (4 ECTS)

Annotation
The Supplementary Studies on Sustainable Development at KIT is based on the conviction that a long-term socially and ecologically compatible coexistence in the global world is only possible if knowledge about necessary changes in science, economy and society is acquired and applied.

The interdisciplinary and transdisciplinary Studies on Sustainable Development enables diverse access to transformation knowledge as well as basic principles and application areas of sustainable development. According to the statutes § 16, a certificate is issued by the ZAK for the complementary studies.

The achievements are also shown in the transcript of records of the degree program and, upon request, in the certificate. They can also be recognized in the interdisciplinary qualifications (see elective information).
In the specialised studies, modules and partial achievements can be recognised within the framework of the additional achievements or e.g. the interdisciplinary qualifications. This must be regulated via the respective subject study programme.

The focus is on experience- and application-oriented knowledge and competences, but theories and methods are also learned. The aim is to be able to represent one's own actions as a student, researcher and later decision-maker as well as an individual and part of society under the aspect of sustainability.

Sustainability is understood as a guiding principle to which economic, scientific, social and individual actions should be oriented. According to this, the long-term and socially just use of natural resources and the material environment for a positive development of global society can only be addressed by means of integrative concepts. Therefore, "education for sustainable development" in the sense of the United Nations programme plays just as central a role as the goal of promoting "cultures of sustainability". For this purpose, practice-centred and research-based learning of sustainability is made possible and the broad concept of culture established at ZAK is used, which understands culture as habitual behaviour, lifestyle and changing context for social actions.

The supplementary study programme conveys the basics of project management, trains teamwork skills, presentation skills and self-reflection. Complementary to the specialised studies at KIT, it creates a fundamental understanding of sustainability, which is important for all professional fields. Integrative concepts and methods are essential: in order to use natural resources in the long term and to shape the global future in a socially just way, not only different disciplines, but also citizens, practitioners and institutions must work together.

Workload
The workload is made up of the number of hours of the individual modules:

- Basic module approx. 180 h
- Elective module approx. 150 h
- Consolidation module approx. 180 h

Total: approx. 510 h

Learning type

- lectures
- seminars
- workshops

Literature
Recommended reading of primary and specialist literature is determined individually by the respective lecturer.

M 4.41 Module: The Black Forest Observatory at Schiltach [M-PHYS-101870]

Responsible: Dr. Thomas Forbriger
Organisation: KIT Department of Physics
Part of: Electives

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
1	pass/fail	Irregular	1 term	German/English	4	1

Mandatory			
T-PHYS-103569	The Black Forest Observatory at Schiltach, Prerequisite	1 CR	Forbriger

Competence Certificate
Report including topics of three research papers discussed in lecture.

Prerequisites
none

Competence Goal
Students can name different tasks of BFO, know which instruments are used at BFO and which questions can be addressed with the dta recorded at BFO. They know the physical principles and can explain how the instruments work. They can explain installation of instruments, and know what has to be considered when installing those instruments in the field. They have an idea about the interpretation of the data measured at BFO.

Students can name research topics where data from BFO is used and can critically discuss those. They know current and previous research projects.

They can summarize, reflect and evaluate their newly gained knowledge about BFO and its current research in a written report.

Content

- Tasks of BFO
- Instruments at BFO
- Data from BFO
- Current research with BFO data
- Current and future research projects at BFO

Module grade calculation
No grade is given.

Workload
30 h:

- Preparation/ lectures at KIT: 5 h
- In-Situ lecture at BFO: 10 h
- Wrap up, writing of report: 15 h

Learning type
In situ lecture:

Lectures at KIT for preparation, one day visit to BFO

Literature
Will be given in lecture.

M 4.42 Module: Theory and Inversion of Seismic Waves (GEOP M TIW) [M-PHYS-101359]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: Geophysics

Credits	Grading scale	Recurrence	Duration	Language	Level	Version
18	Grade to a tenth	Each summer term	1 term	English	4	3

Mandatory			
T-PHYS-102330	Theory of Seismic Waves, Prerequisite	0 CR	Bohlen
T-PHYS-102332	Inversion and Tomography, Prerequisite	0 CR	Ritter
T-PHYS-108636	Seismic Modelling, Prerequisite	0 CR	Bohlen
T-PHYS-106218	Theory and Inversion of Seismic Waves, Exam	18 CR	Bohlen

Competence Certificate

General

To pass the module, the oral exam must be passed. As prerequisites the examinations of other type (of all three courses) must be passed.

The examination prerequisites are successful participation in 'Exercises of Theory of Seismic Wave', 'Exercises of Seismic Modelling' and 'Exercises of Inversion and Tomography'.

The oral exam with a duration of approximately 60 minutes covers the complete content of all exercises and lectures of the module comprehensively. The examinations of other type check the contents of the corresponding exercises.

In general, the examinations of other type can be repeated within 8 weeks, but at the latest within the period of one year. An oral reexamination usually takes place at the beginning of the next semester at the latest. A missed oral reexamination may be repeated once.

Theory of Seismic Waves

Final pass based on successful participation of the exercises. Each exercise deals with a specific topic (e.g., stress and strain tensors, Zoeppritz equations, or rays) and is based on solving a given theoretical problem by means of calculus. In some cases equations and solutions need to be visualized using Matlab (or equivalent tools).

Seismic Modelling

Final pass based on successful participation of the exercises. Each exercise deals with a specific topic (e.g., 1D finite-difference implementation) and is based on hands-on work, usually involving the use of computers.

Inversion and Tomography

Students write reports on their exercise work. These reports are rated. The necessary number of points is explained at the beginning of the individual exercises.

Competence Goal

Theory of Seismic Waves

The students know the fundamental laws and equations of linear elasticity and wave propagation. They understand wave propagation phenomena such as source effects, reflection and transmission or the effects of anisotropy, absorption, dispersion and scattering and can describe them in mathematical terms. They are able to apply the concepts and equations to theoretical problems and relate the theory to phenomena observed in field data.

Seismic Modelling

The students know the fundamental concepts of seismic wavefield simulations, including the mathematical descriptions and their basic numeric implementations. They understand the complexity of wave propagation and the advantages and disadvantages of the individual methods. They are able to apply the methods using synthetic Earth models to calculate amplitudes and traveltimes of propagating elastic and/or acoustic waves.

Inversion and Tomography

The students understand how to invert data to achieve a model of physical parameters. The students realize that seismic waves can be treated in different waves: full waveform, finite-frequency approximations (banana-doughnut theory) and rays. From this they understand how seismic images can be constructed and interpreted. Students are able to evaluate inversion models based on error bonds, resolution matrices and reconstruction tests. They know the complete chain of tomography: data pre-processing, parameterization, inversion, model assessment and interpretation. The students are used to read scientific papers on inversion and tomography and to discuss questions on these papers. Finally the students are able to understand basic inverse problems and read more advanced texts. Practically, the students understand how to code simple problems with Matlab or possibly Python. The students know how to analyze inverse problems using singular value decomposition and other methods.

Content

Theory of Seismic Waves

- Theory of elasticity, stress and strain, elastic tensor, fundamental laws and equations
- Anisotropic elastic wave equation and various simplifications
- Mathematical description of sources, near-field and far-field terms
- Boundary conditions
- Reflection and transmission of plane waves at plane interfaces, Zoeppritz equations
- Surface waves, dispersion relation, phase and group velocity
- Introduction to ray theory, eikonal and transport equations and their solutions
- Absorption and dispersion
- Wave propagation in anisotropic media
- Scattering

Seismic Modelling

- Factors influencing traveltimes and amplitudes of seismic wavefields
- Analytical solutions
- Fast traveltime calculation using the eikonal equation
- Raytracing
- Reflectivity method for acoustic 1D media
- Time-domain finite-difference solutions of the acoustic/elastic wave equations
- Fourier methods
- Introduction to the finite-element method

Inversion and Tomography

- Fundamentals of tomography
- Application of seismic tomography
- Regional to global seismic tomography
- Analysis of tomography problems
- Fundamentals in seismic inversion
- Application of linear and non-linear inversion

Module grade calculation

The grade of the module results from grade of the oral exam.

Workload
18 ECTS in total, corresponding to 540 working hours. For the specific courses:

- Theory of Seismic Waves: 180 h, composed of active time (45 h), wrap-up of the lectures incl. preparation of the oral exam and solving the exercises (135 h)
- Seismic Modelling: 120 h, composed of active time (30 h), wrap-up of the lectures incl. preparation of the oral exam and solving the exercises (90 h)
- Inversion and Tomography: 240 h, composed of active time (60 h), wrap-up of the lectures incl. preparation of the oral exam and solving the exercises (180 h)

Recommendation
Theory of Seismic Waves

Knowledge of differential and vector calculus is essential. Familiarity with Matlab (alternatively Python or Mathematica) is beneficial for certain exercises.

Seismic Modelling

Knowledge of differential and vector calculus is essential. Familiarity with Matlab (alternatively Python or Mathematica) is beneficial for certain exercises.

Inversion and Tomography

Knowledge on fundamentals of seismology and understanding of mathematics, especially matrix calculus. Fundamental skills in Linux, Matlab and computing in general.

Learning type

- Theory of Seismic Waves (V2 Ü1, 3 SWS, 6 ECTS, prerequisite for oral examination)
- Seismic Modelling (V1 Ü1, 2 SWS, 4 ECTS, prerequisite for oral examination)
- Inversion und Tomographie (V2 Ü2, 4 SWS, 8 ECTS , prerequisite for oral examination)

Literature
Theory of Seismic Waves

- Aki and Richards, "Quantitative Seismology", 2003, University Science Books.
- Ben-Menahem and Singh, "Seismic waves and sources", 1981, Springer.
- Dahlen and Tromp, "Theoretical Global Seismology", 1998, Princeton University Press.
- Frank Hadsell, "Tensors of Geophysics for Mavericks and Mongrels", 1995, Society of Exploration Geophysicists.

Seismic Modelling

- Carcione, Herman and Kroode, "Seismic modeling", 2000, Geophysics 67(4).

Inversion and Tomography

- Nolet, G., 2008. A breviary of seismic tomography. Cambridge University Press.
- Aster, R.C., Brochers, B. & Thurber, C.H., 2012. Parameter estimation and inverse problems. Elsevier (2nd ed.).
- Menke, W.A., 2012. Geophysical data analysis: discrete inverse theory. Academic Press (3rd ed.).

5 Courses

T 5.1 Course: 3D reflection seismics [T-PHYS-107806]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck
Organisation: KIT Department of Physics
Part of: M-PHYS-103856 - 3D reflection seismics

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	1	pass/fail	Irregular	1

T 5.2 Course: Array Techniques in Seismology, graded [T-PHYS-112590]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-106196 - Array Techniques in Seismology, graded

Type	Credits	Grading scale	Version
Examination of another type	4	Grade to a third	1

Events					
WT 22/23	4060261	Array Techniques in Seismology	1 SWS	Lecture / 🗣	Ritter
WT 22/23	4060262	Exercises to Array Techniques in Seismology	1 SWS	Practice / 🗣	Ritter, NN
Exams					
WT 22/23	7800140	Array Techniques in Seismology, graded			Ritter

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

Competence Certificate
Grading is based on written reports on exercises. A detailed rating scheme is distributed during the first lecture together with information on the required length of the reports and rating criteria.

Recommendation
Participants need to know the basics of seismology.

T 5.3 Course: Array Techniques in Seismology, not graded [T-PHYS-112593]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-106198 - Array Techniques in Seismology, not graded

Type	Credits	Grading scale	Version
Completed coursework	4	pass/fail	1

Events					
WT 22/23	4060261	Array Techniques in Seismology	1 SWS	Lecture / 🗣	Ritter
WT 22/23	4060262	Exercises to Array Techniques in Seismology	1 SWS	Practice / 🗣	Ritter, NN
Exams					
WT 22/23	7800141	Array Techniques in Seismology, not graded			Ritter

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

Competence Certificate
Written reports on exercises must be submitted, which are assessed and scored on an individual basis. Successful participation requires that the average score of all reports combined exceeds a certain threshold. Detailed information on the threshold, the required length of the reports and the rating criteria are distributed in the first lecture.

Recommendation
Participants need to know the basics of seismology.

T 5.4 Course: Basics Module - Self Assignment BAK [T-ZAK-112653]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

Competence Certificate
The monitoring in this module includes a course credit according to § 5 section 4 in the form of minutes of which two are to be handed in freely chosen topics of the lecture series " Introduction to Applied Studies on Culture and Society ". Length: approx. 6,000 characters each (incl. spaces).

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
Fjordevik, Anneli und Jörg Roche: Angewandte Kulturwissenschaften. Vol. 10. Narr Francke Attempto Verlag, 2019.

Annotation
The Basic Module consists of the lecture “Introduction to Supplementary Studies on Culture and Society”, which is offered only in the winter semester. It is therefore recommended that students start their studies in the winter semester and complete them before module 2.

T 5.5 Course: Basics Module - Self Assignment BeNe [T-ZAK-112345]

Responsible: Christine Myglas
Organisation:
Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

Competence Certificate
The monitoring in this module includes a course credit according to § 5 section 4:

Introduction to Sustainable Development in the form of minutes of which two are to be handed in freely chosen topics of the lecture series "Introduction to Sustainable Development". Length: approx. 6,000 characters each (incl. spaces).

or

Sustainability Spring Days at KIT in the form of a reflection report on all components of the project days "Sustainability Spring Days at KIT". Length approx. 12,000 characters (incl. spaces).

Prerequisites
None

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
Kropp, Ariane: Grundlagen der Nachhaltigen Entwicklung: Handlungsmöglichkeiten und Strategien zur Umsetzung. Springer-Verlag, 2018.

Pufé, Iris: Nachhaltigkeit. 3. überarb. Edition, UTB, 2017.

Roorda, Niko, et al.: Grundlagen der nachhaltigen Entwicklung. Springer-Verlag, 2021.

Annotation
Module Basics consists of the lecture " Introduction to Sustainable Development ", which is only offered in the summer semester or alternatively of the project days " Sustainability Spring Days at KIT ", which is only offered in the winter semester. It is recommended to complete the course before Elective Module an Specialisation Module.

In exceptional cases, Elective Module or Specialisation Module can also be completed simultaneously with Basics Module. However, the prior completion of the advanced modules Elective and Specialisation should be avoided.

T 5.6 Course: Classical Physics Laboratory Courses II [T-PHYS-102290]

Responsible: Prof. Dr. Ulrich Husemann
Dr. Hans Jürgen Simonis
PD Dr. Roger Wolf

Organisation: KIT Department of Physics

Part of: M-PHYS-101354 - Classical Physics Laboratory Course II

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	6	pass/fail	Each summer term	1

Events					
ST 2023	4011213	Praktikum Klassische Physik II (Kurs 1)	6 SWS	Practical course / 🗣	Husemann, Wolf, Simonis
ST 2023	4011223	Praktikum Klassische Physik II (Kurs 2)	6 SWS	Practical course / 🗣	Husemann, Wolf, Simonis

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

Prerequisites
none

T 5.7 Course: Eifel Seismology and Volcanology Course [T-PHYS-110870]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-105382 - Eifel Seismology and Volcanology Course

Type	Credits	Grading scale	Expansion	Version
Examination of another type	2	Grade to a third	1 terms	1

T 5.8 Course: Elective Module - Subject, Body, Individual: the Other Side of Sustainability - Self Assignment BeNe [T-ZAK-112349]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
The content of the Basics Module is helpful.

T 5.9 Course: Elective Module - Sustainability Assessment of Technology - Self Assignment BeNe [T-ZAK-112348]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
The content of the Basics Module is helpful.

T 5.10 Course: Elective Module - Sustainability in Culture, Economy and Society - Self Assignment BeNe [T-ZAK-112350]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
The content of the Basics Module is helpful.

T 5.11 Course: Elective Module - Sustainable Cities and Neighbourhoods - Self Assignment BeNe [T-ZAK-112347]

Organisation: University

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
Examination of another kind according to § 7 section 7 in the form of a presentation in the selected course.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
The content of the Basics Module is helpful.

T 5.12 Course: Full-waveform inversion [T-PHYS-109272]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck

Organisation: KIT Department of Physics

Part of: M-PHYS-104522 - Full-waveform Inversion, not graded

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	6	pass/fail	Each winter term	1

Events					
WT 22/23	4060181	Full-waveform inversion	2 SWS	Lecture / 🗣	Bohlen, Gao
WT 22/23	4060182	Exercises on Full-waveform inversion	1 SWS	Practice / 🗣	Bohlen, Gao

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

T 5.13 Course: Geological Hazards and Risk [T-PHYS-103525]

Responsible: Dr. Andreas Schäfer
Organisation: KIT Department of Physics
Part of: M-PHYS-101833 - Geological Hazards and Risk

Type	Credits	Grading scale	Recurrence	Version
Examination of another type	8	Grade to a third	Each winter term	2

Events					
WT 22/23	4060121	Geological Hazards and Risk	2 SWS	Lecture / 🗣	Schäfer, Rietbrock
WT 22/23	4060122	Exercises on Geological Hazards and Risk	2 SWS	Practice / 🗣	Schäfer, Rietbrock
Exams					
WT 22/23	7800114	Geological Hazards and Risk			Rietbrock

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

T 5.14 Course: Geological Hazards and Risk, not graded [T-PHYS-110713]

Responsible: Dr. Andreas Schäfer
Organisation: KIT Department of Physics
Part of: M-PHYS-105279 - Geological Hazards and Risk, not graded

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	8	pass/fail	Each winter term	1

Events					
WT 22/23	4060121	Geological Hazards and Risk	2 SWS	Lecture / 🗣	Schäfer, Rietbrock
WT 22/23	4060122	Exercises on Geological Hazards and Risk	2 SWS	Practice / 🗣	Schäfer, Rietbrock

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

T 5.15 Course: Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, exam [T-PHYS-103673]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101952 - Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, graded

Type	Credits	Grading scale	Version
Examination of another type	1	Grade to a third	1

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-103571 - Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, Studienleistung must have been passed.

T 5.16 Course: Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, Studienleistung [T-PHYS-103571]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101872 - Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, not graded
M-PHYS-101952 - Geophysical Deep Sounding at Volcanoes and the Example of the Vogelsberg, graded

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

T 5.17 Course: Geophysical Monitoring of Tunnel Constructions, Prerequisite [T-PHYS-106248]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-103141 - Geophysical Monitoring of Tunnel Constructions

Type	Credits	Grading scale	Version
Completed coursework	1	pass/fail	1

T 5.18 Course: Hazard and Risk Assessment of Mediterranean Volcanoes, exam [T-PHYS-103674]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101873 - Hazard and Risk Assessment of Mediterranean Volcanoes, graded

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

Prerequisites
T-PHYS-103572 - Geophysikalische Bewertung und Gefährdungspotential mediterraner Vulkane, Studienleistung (Prerequisite) must have been passed.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-103572 - Hazard and Risk Assessment of Mediterranean Volcanoes, Prerequisite must have been passed.

T 5.19 Course: Hazard and Risk Assessment of Mediterranean Volcanoes, Prerequisite [T-PHYS-103572]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101873 - Hazard and Risk Assessment of Mediterranean Volcanoes, graded

Type	Credits	Grading scale	Version
Completed coursework	4	pass/fail	1

Competence Certificate
See module

Prerequisites
Exam: Introduction to Volcanology (each summer semester at GPI), or equivalent

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-103553 - Introduction to Volcanology, Prerequisite must have been passed.

T 5.20 Course: Historical Seismology for Hazard Evaluation, Prerequisite [T-PHYS-103679]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101961 - Historical Seismology for Hazard Evaluation

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	1	pass/fail	Irregular	1

T 5.21 Course: In-depth Module - Doing Culture - Self Assignment BAK [T-ZAK-112655]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation
The content of the Basic Modul is helpful.

T 5.22 Course: In-depth Module - Global Cultures - Self Assignment BAK [T-ZAK-112658]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation
The content of the Basic Modul is helpful.

T 5.23 Course: In-depth Module - Media & Aesthetics - Self Assignment BAK [T-ZAK-112656]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation
The content of the Basic Modul is helpful.

T 5.24 Course: In-depth Module - Spheres of Life - Self Assignment BAK [T-ZAK-112657]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation
The content of the Basic Modul is helpful.

T 5.25 Course: In-depth Module - Technology & Responsibility - Self Assignment BAK [T-ZAK-112654]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Examination of another type	3	Grade to a third	1

Competence Certificate
At least two presentations must be given: An examination of another kind according to § 5 section 3 (3) in the form of a presentation in one of the chosen courses (3 ECT).
In a third seminar, either (a) a presentation is held (preliminary study achievement) which remains not graded and a topic-related term paper is submitted or (b) a written exam is taken.
The three courses can be selected individually from the 5 thematic blocks or – in exceptional cases and according to the agreement with the responsible lecturer – all three courses can be selected from one block in the sense of a specialization.
In addition, an oral examination is taken, which relates to the content of two of the chosen three courses.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Annotation
The content of the Basic Modul is helpful.

T 5.26 Course: Induced Seismicity, exam [T-PHYS-103677]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101959 - Induced Seismicity, graded

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

Competence Certificate
The procedure will be announced in the lecture.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-103575 - Induced Seismicity, Studienleistung must have been passed.

T 5.27 Course: Induced Seismicity, Studienleistung [T-PHYS-103575]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101959 - Induced Seismicity, graded

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	3	pass/fail	Irregular	1

T 5.28 Course: In-Situ: Summer School Bandung: Seismology/Geohazards [T-PHYS-108691]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-104196 - In-Situ: Summer School Bandung: Seismology/Geohazards

Type	Credits	Grading scale	Version
Examination of another type	6	Grade to a third	1

Prerequisites
none

T 5.29 Course: In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region [T-PHYS-112830]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-106322 - In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region

Type	Credits	Grading scale	Recurrence	Expansion	Version
Examination of another type	6	Grade to a third	Irregular	1 terms	1

Events					
ST 2023	4060351	In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region	2 SWS	Lecture / 🗣	Rietbrock, NN
ST 2023	4060352	Exercises on In-Situ: Tectonics and Seismic Hazard in the Mediterranean Region	2 SWS	Practice / 🗣	Rietbrock, NN

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

Competence Certificate
Students solve exercise sheets, prepare and give a presentation and write a final report.

T 5.30 Course: International Workshop on Current Geophysical Research Topics [T-PHYS-110871]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-105383 - International Workshop on Current Geophysical Research Topics

Type	Credits	Grading scale	Expansion	Version
Completed coursework	2	pass/fail	1 terms	2

Events					
ST 2023	4060371	International workshop on current Geophysical research topics	1 SWS	Lecture	Rietbrock

T 5.31 Course: Introduction to Research in a Scientific Sub-Field Including a Seminar Paper [T-PHYS-103355]

Organisation: KIT Department of Physics
Part of: M-PHYS-101361 - Introduction to Scientific Practice

Type	Credits	Grading scale	Version
Completed coursework	16	pass/fail	1

Exams			
WT 22/23	7800093	Introduction to Research in a Scientific Sub-Field Including a Seminar paper	Bohlen, Ritter, Rietbrock

T 5.32 Course: Introduction to Volcanology, Exam [T-PHYS-103644]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101866 - Introduction to Volcanology, graded

Type	Credits	Grading scale	Version
Examination of another type	1	Grade to a third	1

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-103553 - Introduction to Volcanology, Prerequisite must have been passed.

T 5.33 Course: Introduction to Volcanology, Prerequisite [T-PHYS-103553]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101866 - Introduction to Volcanology, graded

Type	Credits	Grading scale	Version
Completed coursework	3	pass/fail	1

T 5.34 Course: Inversion and Tomography, Prerequisite [T-PHYS-102332]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101359 - Theory and Inversion of Seismic Waves

Type	Credits	Grading scale	Version
Completed coursework (written)	0	pass/fail	1

Events					
ST 2023	4060231	Inversion and Tomography	2 SWS	Lecture / 🗣	Ritter
ST 2023	4060232	Exercises to Inversion and Tomography	2 SWS	Practice / 🗣	Ritter, Gao

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

T 5.35 Course: Master's Thesis [T-PHYS-103350]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101730 - Modul Master's Thesis

Type	Credits	Grading scale	Version
Final Thesis	30	Grade to a third	1

Final Thesis
This course represents a final thesis. The following periods have been supplied:

Submission deadline 6 months
Maximum extension period 3 months
Correction period 8 weeks

This thesis requires confirmation by the examination office.

T 5.36 Course: Modern Physics Laboratory Courses [T-PHYS-102291]

Responsible: PD Dr. Andreas Naber
Organisation: KIT Department of Physics
Part of: M-PHYS-101355 - Modern Physics Laboratory Course

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	6	pass/fail	Each term	1

Events					
WT 22/23	4011313	Praktikum Moderne Physik (Kurs 1)	4 SWS	Practical course / 🗣	Naber, Guigas, Sürgers, Wolf
WT 22/23	4011323	Praktikum Moderne Physik (Kurs 2)	4 SWS	Practical course / 🗣	Naber, Guigas, Sürgers, Wolf
ST 2023	4011313	Praktikum Moderne Physik (Kurs 1)	4 SWS	Practical course / 🗣	Naber, Guigas, Sürgers, Wolf
ST 2023	4011323	Praktikum Moderne Physik (Kurs 2)	4 SWS	Practical course / 🗣	Naber, Guigas, Sürgers, Wolf
Exams					
WT 22/23	7800029	Modern Physics Laboratory Courses			Naber

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

Prerequisites
none

T 5.37 Course: Near Surface Geophysical Prospecting, Prerequisite [T-PHYS-103645]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101946 - Near Surface Geophysical Prospecting

Type	Credits	Grading scale	Version
Completed coursework	1	pass/fail	1

T 5.38 Course: Near-surface seismic and GPR [T-PHYS-107793]

Responsible: Prof. Dr. Thomas Bohlen
Yudi Pan
Organisation: KIT Department of Physics
Part of: M-PHYS-103855 - Near-surface seismic and GPR

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	6	pass/fail	Each winter term	1

T 5.39 Course: Observatory Course [T-PHYS-111311]

Responsible: Dr. Thomas Forbriger
Organisation: KIT Department of Physics
Part of: M-PHYS-105662 - Observatory Course

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	3	pass/fail	Irregular	1

Events					
WT 22/23	4060914	Observatory course	3 SWS	Practical course	Forbriger, NN
Exams					
WT 22/23	7800139	Observatory Course			Forbriger

T 5.40 Course: Oral Exam - Supplementary Studies on Culture and Society [T-ZAK-112659]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Competence Certificate
An oral examination according to § 7 section 6 of approx. 45 minutes on the contents of two courses from In-depth Module.

Prerequisites
Prerequisite for the 'Oral Examination' is the successful completion of Modules 1 and 3 and the required elective sections in Module 2.

T 5.41 Course: Oral Exam - Supplementary Studies on Sustainable Development [T-ZAK-112351]

Organisation:

Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Oral examination	4	Grade to a third	1

Competence Certificate
An oral examination according to § 7 section 6 of approx. 45 minutes on the contents of two courses from Elective Module.

Prerequisites
A requirement for the Supplementary Course: Oral examination is the successful completion of the modules Basics Module and Specialisation Module and the required electives of Elective Module.

T 5.42 Course: Physical Methods in Volcano Seismology [T-PHYS-111334]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-105679 - Physical Methods in Volcano Seismology

Type	Credits	Grading scale	Version
Examination of another type	6	Grade to a third	1

T 5.43 Course: Physics of Seismic Instruments, Prerequisite [T-PHYS-102325]

Responsible: Dr. Thomas Forbriger
Organisation: KIT Department of Physics
Part of: M-PHYS-101358 - Seismometry, Signal Processing and Seismogram Analysis

Type	Credits	Grading scale	Version
Completed coursework (written)	0	pass/fail	1

Events					
WT 22/23	4060051	Physics of seismic instruments	2 SWS	Lecture / 🗣	Forbriger, Rietbrock
WT 22/23	4060052	Exercise on physics of seismic instruments	1 SWS	Practice / 🗣	Toularoud, Forbriger, Rietbrock
Exams					
WT 22/23	7800003	Physics of Seismic Instruments, Prerequisite			Forbriger

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

T 5.44 Course: Physics of the Lithosphere, exam [T-PHYS-103678]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101960 - Physics of the Lithosphere, graded

Type	Credits	Grading scale	Version
Examination of another type	1	Grade to a third	1

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-103574 - Physics of the Lithosphere, Studienleistung must have been passed.

T 5.45 Course: Physics of the Lithosphere, Studienleistung [T-PHYS-103574]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101960 - Physics of the Lithosphere, graded

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

T 5.46 Course: Practice Module [T-ZAK-112660]

Responsible: Dr. Christine Mielke
Christine Myglas

Organisation:

Part of: M-ZAK-106235 - Supplementary Studies on Culture and Society

Type	Credits	Grading scale	Version
Completed coursework	4	pass/fail	1

Competence Certificate
Internship (3 ECT)
Report within the framework of the practical training (Length approx. 18,000 characters (incl. spaces)
(1 ECT)

Prerequisites
none

Annotation
Knowledge from the Basic Module and the Elective Module is helpful.

T 5.47 Course: Recent Geodynamics [T-BGU-101771]

Responsible: Dr. Malte Westerhaus
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: M-BGU-101030 - Recent Geodynamics

Type	Credits	Grading scale	Version
Oral examination	3	Grade to a third	1

Events					
WT 22/23	6025103	Recent Geodynamics, Lecture	2 SWS	Lecture /	Westerhaus
WT 22/23	6025104	Recent Geodynamics, Exercises	1 SWS	Practice /	Westerhaus
Exams					
WT 22/23	8293101771	Recent Geodynamics			Westerhaus

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

Competence Certificate
Oral exam (about 30 min.) according § 4 para. 2 No. 2 SPO M.Sc. Geodäsie und Geoinformatik.

Prerequisites
The part T-BGU-101772 Rezente Geodynamik, Vorleistung must be passed.

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-BGU-101772 - Recent Geodynamics, Prerequisite must have been passed.

Recommendation
Basics of Geophysics and Physical Geodesy are helpful

T 5.48 Course: Recent Geodynamics, Prerequisite [T-BGU-101772]

Responsible: Dr. Malte Westerhaus
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: M-BGU-101030 - Recent Geodynamics

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	1	pass/fail	Each winter term	2

Events					
WT 22/23	6025103	Recent Geodynamics, Lecture	2 SWS	Lecture /	Westerhaus
WT 22/23	6025104	Recent Geodynamics, Exercises	1 SWS	Practice /	Westerhaus
Exams					
WT 22/23	8293101772	Recent Geodynamics, Prerequisite			Westerhaus

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

Competence Certificate
The assessment consists of a coursework according § 4 para. 3 SPO M.Sc. Geodäsie und Geoinformatik. The achievement consists in

- Practical computer training (topic "seismic cycle" (program: Coulomb):
  - attendance
  - scientific report (5-10 pages)
- Detailed discussion of a selected topic of "Recent Geodynamics"; the students prepare and give a scientific presentation (duration approx. 25 min) and discuss their findings (5-10 min) .

Prerequisites
none

Recommendation
Basics of Geophysics and Physical Geodesy are helpful

T 5.49 Course: Scientific Seminars [T-PHYS-102335]

Organisation: KIT Department of Physics
Part of: M-PHYS-101357 - Scientific Seminars

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each term	1

Events					
WT 22/23	4060294	Institutsseminar	2 SWS	Seminar / 🗣	Bohlen, Rietbrock
WT 22/23	6339052	Fachgespräch Hydrogeologie und Ingenieurgeologie	1 SWS	Lecture / 🗣	Eingeladene Gäste, Goodwin, Goldscheider
ST 2023	4060334	Institutsseminar	2 SWS	Seminar / 🗣	Bohlen, Rietbrock
ST 2023	6339041	Fachgespräch Hydrogeologie und Ingenieurgeologie	1 SWS	Seminar / 💻	Goldscheider, Goodwin
Exams					
WT 22/23	7800094	Scientific Seminars			Forbriger
ST 2023	7800073	Scientific Seminars			Forbriger

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

Prerequisites
none

T 5.50 Course: Seismic Data Processing, Coursework [T-PHYS-108686]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck

Organisation: KIT Department of Physics

Part of: M-PHYS-104186 - Seismic Data Processing with Final Report (graded)
M-PHYS-104188 - Seismic Data Processing with final report (ungraded)
M-PHYS-104189 - Seismic Data Processing without Final Report (Ungraded)

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

Exams			
ST 2023	7800103	Seismic Data Processing, coursework	Hertweck, Bohlen

T 5.51 Course: Seismic Data Processing, Final Report (graded) [T-PHYS-108656]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck
Organisation: KIT Department of Physics
Part of: M-PHYS-104186 - Seismic Data Processing with Final Report (graded)

Type	Credits	Grading scale	Version
Examination of another type	4	Grade to a third	1

Events					
ST 2023	4060321	Seismic Data Processing	1 SWS	Lecture / 🗣	Hertweck, Bohlen
ST 2023	4060322	Exercises to Seismic Data Processing	2 SWS	Practice / 🗣	Hertweck, Houpt, Bohlen
Exams					
ST 2023	7800104	Seismic Data Processing, final report (graded)			Hertweck, Bohlen

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

Prerequisites
Successful participation on "Seismic Data Processing, course achievement"

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-108686 - Seismic Data Processing, Coursework must have been passed.

T 5.52 Course: Seismic Data Processing, final report (ungraded) [T-PHYS-108657]

Responsible: Prof. Dr. Thomas Bohlen
Dr. Thomas Hertweck
Organisation: KIT Department of Physics
Part of: M-PHYS-104188 - Seismic Data Processing with final report (ungraded)

Type	Credits	Grading scale	Version
Completed coursework	4	pass/fail	1

Events					
ST 2023	4060321	Seismic Data Processing	1 SWS	Lecture / 🗣	Hertweck, Bohlen
ST 2023	4060322	Exercises to Seismic Data Processing	2 SWS	Practice / 🗣	Hertweck, Houpt, Bohlen
Exams					
ST 2023	7800105	Seismic Data Processing, final report (ungraded)			Hertweck, Bohlen

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

Prerequisites
Successful participation on "Seismic Data Processing, course achievement"

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-108686 - Seismic Data Processing, Coursework must have been passed.

T 5.53 Course: Seismic Modelling, Prerequisite [T-PHYS-108636]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101359 - Theory and Inversion of Seismic Waves

Type	Credits	Grading scale	Version
Completed coursework (written)	0	pass/fail	1

Events					
ST 2023	4060261	Seismic Modelling	1 SWS	Lecture / 🗣	Bohlen
ST 2023	4060262	Exercises to Seismic Modelling	1 SWS	Practice / 🗣	Bohlen
Exams					
ST 2023	7800100	Seismic Modelling, Prerequisite			Bohlen

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

T 5.54 Course: Seismics, Prerequisite [T-PHYS-109266]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101358 - Seismometry, Signal Processing and Seismogram Analysis

Type	Credits	Grading scale	Version
Completed coursework (written)	0	pass/fail	1

Events					
WT 22/23	4060111	Seismics	2 SWS	Lecture / 🗣	Bohlen, Hertweck
WT 22/23	4060112	Exercises on Seismics	2 SWS	Practice / 🗣	Bohlen, Hertweck, Houpt
Exams					
WT 22/23	7800006	Seismics, Prerequisite			Bohlen, Hertweck

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

T 5.55 Course: Seismology, Prerequisite [T-PHYS-109267]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-101358 - Seismometry, Signal Processing and Seismogram Analysis

Type	Credits	Grading scale	Version
Completed coursework (written)	0	pass/fail	1

Events					
WT 22/23	4060171	Seismology	2 SWS	Lecture / 🗣	Kufner, Gao, Rietbrock
WT 22/23	4060172	Exercises on Seismology	2 SWS	Practice / 🗣	Kufner, Gao, Linder, Rietbrock
Exams					
WT 22/23	7800122	Seismology, Prerequisite			Rietbrock

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

T 5.56 Course: Seismometry, Signal Processing and Seismogram Analysis, Exam [T-PHYS-106217]

Responsible: Prof. Dr. Thomas Bohlen
Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-101358 - Seismometry, Signal Processing and Seismogram Analysis

Type	Credits	Grading scale	Recurrence	Version
Oral examination	22	Grade to a third	Each winter term	2

Exams			
WT 22/23	7800007	Seismometry, Signal Processing and Seismogram Analysis, exam	Bohlen, Rietbrock, Ritter

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-102325 - Physics of Seismic Instruments, Prerequisite must have been passed.
2. The course T-PHYS-109266 - Seismics, Prerequisite must have been passed.
3. The course T-PHYS-109267 - Seismology, Prerequisite must have been passed.

T 5.57 Course: Seminar on Recent Topics of Applied Geophysics [T-PHYS-107675]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101360 - Scientific Focusing Phase

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (oral)	10	pass/fail	Each term	1

Events					
WT 22/23	4060234	Seminar on Applied Geophysics	2 SWS	Seminar / 🗣	Bohlen, Hertweck
ST 2023	4060284	Seminar on Applied Geophysics	2 SWS	Seminar / 🗣	Bohlen, Hertweck
Exams					
WT 22/23	7800110	Seminar on Applied Geophysics			Bohlen

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

T 5.58 Course: Seminar on Recent Topics of General Geophysics [T-PHYS-107676]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-101360 - Scientific Focusing Phase

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (oral)	10	pass/fail	Each term	1

Events					
WT 22/23	4060274	Current Topics in Seismology and Hazard	2 SWS	Seminar / 🗣	Rietbrock, Forbriger, Kufner, Gao
ST 2023	4060274	Current Topics in Seismology and Hazard	2 SWS	Seminar / 🗣	Rietbrock
Exams					
WT 22/23	7800111	Current Topics in Seismology and Hazard			Rietbrock

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

T 5.59 Course: Seminar on Recent Topics of Risk Science [T-PHYS-107673]

Responsible: Prof. Dr. Andreas Rietbrock
Organisation: KIT Department of Physics
Part of: M-PHYS-103803 - Seminar on Recent Topics of Risk Science

Type	Credits	Grading scale	Recurrence	Version
Completed coursework	4	pass/fail	Each winter term	1

T 5.60 Course: Seminar Seismological Analysis [T-PHYS-110593]

Responsible: apl. Prof. Dr. Joachim Ritter
Organisation: KIT Department of Physics
Part of: M-PHYS-101360 - Scientific Focusing Phase

Type	Credits	Grading scale	Recurrence	Version
Completed coursework (oral)	10	pass/fail	Each term	1

Events					
WT 22/23	4060244	Seminar Seismological Analysis	2 SWS	Seminar / 🗣	Ritter
Exams					
WT 22/23	7800036	Seminar Seismological Analysis			Ritter

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

T 5.61 Course: Specialisation Module - Self Assignment BeNe [T-ZAK-112346]

Responsible: Christine Myglas
Organisation:
Part of: M-ZAK-106099 - Supplementary Studies on Sustainable Development

Type	Credits	Grading scale	Version
Examination of another type	6	Grade to a third	1

Competence Certificate
The monitoring occurs in the form of several supplementary courses, which usually comprise a presentation of the (group) project, a written elaboration of the (group) project as well as an individual term paper, if necessary with appendices (examination performances of other kind according to statutes § 5 section 3 No. 3 or § 7 section 7).

The presentation is usually with the accompanying practice partners, as well as the written paper.

Prerequisites
Active participation in all three mandatory components.

Self service assignment of supplementary stdues
This course can be used for self service assignment of grade aquired from the following study providers:

- Zentrum für Angewandte Kulturwissenschaft und Studium Generale
- ZAK Begleitstudium

Recommendation
Knowledge from 'Basic Module ' and 'Elective Module ' is helpful.

T 5.62 Course: Structural Geology and Tectonics [T-BGU-103712]

Responsible: apl. Prof. Dr. Agnes Kontny
Organisation: KIT Department of Civil Engineering, Geo and Environmental Sciences
Part of: M-BGU-101996 - Structural Geology and Tectonics

Type	Credits	Grading scale	Version
Written examination	4	Grade to a third	1

Events					
WT 22/23	6339008	Strukturgeologie und Tektonik	3 SWS	Lecture / Practice (/ 🗣	Kontny

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

Prerequisites
none

T 5.63 Course: The Black Forest Observatory at Schiltach, Prerequisite [T-PHYS-103569]

Responsible: Dr. Thomas Forbriger
Organisation: KIT Department of Physics
Part of: M-PHYS-101870 - The Black Forest Observatory at Schiltach

Type	Credits	Grading scale	Version
Completed coursework	1	pass/fail	1

T 5.64 Course: Theory and Inversion of Seismic Waves, Exam [T-PHYS-106218]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101359 - Theory and Inversion of Seismic Waves

Type	Credits	Grading scale	Version
Oral examination	18	Grade to a third	2

Exams			
ST 2023	7800053	Theory and Inversion of Seismic Waves, exam	Bohlen, Ritter

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-PHYS-102330 - Theory of Seismic Waves, Prerequisite must have been passed.
2. The course T-PHYS-102332 - Inversion and Tomography, Prerequisite must have been passed.
3. The course T-PHYS-108636 - Seismic Modelling, Prerequisite must have been passed.

T 5.65 Course: Theory of Seismic Waves, Prerequisite [T-PHYS-102330]

Responsible: Prof. Dr. Thomas Bohlen
Organisation: KIT Department of Physics
Part of: M-PHYS-101359 - Theory and Inversion of Seismic Waves

Type	Credits	Grading scale	Version
Completed coursework (written)	0	pass/fail	1

Events					
ST 2023	4060221	Theory of Seismic Waves	2 SWS	Lecture / 🗣	Bohlen, Hertweck
ST 2023	4060222	Exercises to Theory of Seismic Waves	1 SWS	Practice / 🗣	Hertweck, Bohlen
Exams					
ST 2023	7800054	Theory of Seismic Waves, Prerequisite			Bohlen, Hertweck

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

T 5.66 Course: Wildcard [T-PHYS-106253]

Organisation: University
Part of: M-PHYS-103142 - Module Wildcard Electives

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

T 5.67 Course: Wildcard [T-PHYS-104677]

Organisation: KIT Department of Physics
Part of: M-PHYS-102349 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

T 5.68 Course: Wildcard [T-PHYS-104675]

Organisation: KIT Department of Physics
Part of: M-PHYS-102349 - Interdisciplinary Qualifications

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

T 5.69 Course: Wildcard [T-PHYS-106249]

Organisation: University
Part of: M-PHYS-103142 - Module Wildcard Electives

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1

T 5.70 Course: Wildcard Additional Examinations 1 [T-PHYS-103898]

Organisation: University
Part of: M-PHYS-102020 - Further Examinations

Type	Credits	Grading scale	Version
Completed coursework	2	pass/fail	1

T 5.71 Course: Wildcard Additional Examinations 11 [T-PHYS-103937]

Organisation: University
Part of: M-PHYS-102020 - Further Examinations

Type	Credits	Grading scale	Version
Examination of another type	2	Grade to a third	1