Module Handbook
Remote Sensing and Geoinformatics
(MSc)

KIT-Department of Civil Engineering,Geo and Environmental Sciences

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Contents

Chapter 1

The Handbook of Modules: Purpose and Organization

This module handbook is the relevant document providing information on the structure and the contents of the master's degree program Remote Sensing and Geoinformatics. It contains helpful information and offers guidance for selecting courses and planning the studies. The organization of the degree program and its modules are described in detail. This document is meant to provide all necessary information for tailoring an interdisciplinary course of studies compliant with each student's personal interests and needs.

Chapter 2 of this document describes the contents and structure of the master program as a whole. In Chapter 3 the qualification targets are summarized. Section 4 gives an overview over the courses of the modules and the applicable modes of examination. The detailed decriptions of each module are reported in Chapter 5. Chapter 6 includes some exemplary realizations of a schedule. These are not meant as recommendations but as demonstrations of the feasibility of a study plan with the minimum required credit points.

Chapter 2

Contents and Structure of the Master Program

2.1 The Master Program

The purpose of the master program "Remote Sening and Geoinformatics" offered by the Karslruhe Institute of Technology (KIT) is to deepen and complement the scientific qualification the student has acquired in one of the related bachelor programs. The program is composed of a balanced combination of lectures, exercises, and seminars. In the compulsory modules of the topic "Remote Sensing" the students, which may have bachelor's degrees in different fields, will acquire a common basis of knowledge upon which the more specialized courses can build. The selection of one out of six profiles allows for a specialization according to the student's interests as well as for some flexibility to react to the developments of the employment market. First experience in scientific work is gained in "Lab Rotations". The final step is the master thesis on a topic in the field of remote sensing and/or geoinformatics; the master thesis shall be finished within 6 months. Successful students are awarded with the degree "Master of Science (M. Sc.)" in "Remote Sensing and Geoinformatics"

The language of the program is English. Some elective courses may also be offered in German Language. These are, however, not required to finish the program.

The following coding of modules is used:

Table 2.1: Coding of the modules

RSGI-			Course within Remote Sensing and Geoinformatics
	M		Master Program
		R	Topic "Remote Sensing"
			CR Computer Vision and Remote Sensing
			GI Geoinformatics
			RA Remote Sensing of the Atmosphere
			FE Fundamentals of Environmental Geodesy
		M	Topic "Mathematics and Beyond"
			CM Compulsory Modules
			CE Compulsory Elective Modules
		P	Sub-Profile
		PCV	Sub-Profile Computer Vision
		PGI	Sub-Profile Geoinformatics
		PRA	Sub-Profile Remote Sensing of the Atmosphere
		PEG	Sub-Profile Environmental Geodesy
		S	Supplementary Modules
			LC Language Courses
			KC Key Competences
			SW Scientific Writing
			PM Project Management
			PA Allocation of Funds/Project Aquisition
		L	Lb Rotation
		T	Master Thesis

All important information and regulations are available for download:
http://gug.bgu.kit.edu/master.php

2.2 The Modular Structure of the Master Program

This master program is organized in various topics (Remote Sensing, Mathematics and Beyond, etc.), and each topic is in itself organized in multiple subjects. Each module consists of one or multiple successive courses. Usually, a module is finished by passing the related examination. The amount of work related to a module is reflected by the respective credit points (CP) which are booked after the successful finalization of the module. In this master program, some of the modules are compulsory but there are a large number of compulsory elective or fully elective modules. This allows to tailor this interdisciplinary study program to the needs (both with respect to the time available and the contents) according to the personal needs, interests and job perspectives. This module handbook describes the modules of the degree program with respect to

- the composition of the modules,
- the number of credit points associated with the module,
- the dependencies of the modules among each other,
- the learning objectives of the module
- the mode of control of success
- the calculation of grades

While the module handbook provides some necessary orientation and is meant to be a useful guide for planning the studies, it does by no means make the university calendar obsolet, which contains information about the actual data of each course (e.g. time and place of a course).

2.2.1 Finalization of a Module

Usually the final examination associated with a module covers the entire content of all courses of the module on one examination date. The module is successfully completed after passing the related examination with grade 4.0 or better. The weight of this grade in the calculation of the final grade is defined by the credit points of the module. Failed examinations must be repeated (see also below).

Online registration for module examinations is made via the SLE system, where the following actions are supported

- registration for examination or cancellation
- inquiry about results of the examination
- compilation of a summary of grades achieved so far.

Further information on the "Studierendenportal" is available at https://studium.kit.edu/

2.2.2 Repetition of Examinations

Possibilities of repetition of examinations are described in §8 of the " Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den Masterstudiengang Remote Sensing and Geoinformatics".

2.2.3 Choices of Modules

Within topics there are compulsory modules and compulsory selective modules. The compulsory modules are associated with fewer credit points than required for the completion of the topic. The missing credit points can be obtained by compulsory elective modules of this topic of the student's choice.

Each student selects one out of six profiles. As described above for topics in a general sense, each profile contains compulory and elective modules. The total number of ECTS points from this profile shall be at least 20 in two semesters, whereof 10 have to be reached in the compulsory modules and 10 in the compulsory elective modules.

Knowledge of a second European language besides English is of great use to improve job market perspectives. Within the topic "Key Competences Modules" participation in a language course is highly recommended; for students with no or limited knowledge of German, a German-language course would be advisable. Further, participation in at least one seminar course is compulsory, regardless which topic the seminar is assigned to. Beyond this, modules from any other profile or modules offered by other degree programs can be selected as part of the topic "Supplementary Modules". This shall foster interdisciplinarity but to avoid too extravagant choices, approval by the Examination Committee is required.

2.2.4 Voluntary Modules/Additional Examinations

The purpose of voluntary modules is to develop a better interdisciplinary view and to develop competences overarching over specific fields. The grades of voluntary modules are not relevant for the final grade. When the student registers for the examination of a voluntary module, this has to be indicated as such. Retroactive rebooking of credit points and grades achieved for voluntary modules to compulsory modules, compulsory elective modules or elective modules is not possible. No more than 30 credit points can be acquired for voluntary modules.

2.2.5 Preliminary Examinations

The possibility of preliminary Examinations ("Mastervorzugsleistungen") is regulated by the "Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den Masterstudiengang Remote Sensing and Geoinformatics".

2.2.6 More Details

Information on all legal and official details of this master program are provided by the Study Regulations ("Studienordnung") and the examination regulations ("Prüfungsordnung").

2.3 Overview over the Structure of the Program and the Course of the Study

The total sum of credit points (CP) is 120. They are distributed over the courses as follows:

- **Remote Sensing 23 CP**
- **Mathematics and Beyond 15 CP**
- **Profile Courses 20 CP**
  - Choice of 1 out of 6 profile courses, 20 CP.
  - Each profile contains compulory (10 CP) and optional (10 CP) modules.
- **Supplementary Modules 8 CP**
- **Lab Rotation 20 CP**
- **Key Competences 4 CP**
- **Master Thesis 30 CP**

Table 2.2: The Sequence of Courses. Depending on the choice of profiles and courses, the actual order in which topics and courses are heard may change. Possible sample courses are presented in Chapter 6.

	1st Semester			2nd Semester			3rd Semester		4th Semester
1st half of semester	Compulsory **Remote Sensing Part 1** Computer Vision and Rem. Sensing Geoinformatics Remote Sensing of the Atmosphere Fundamentals of Environmental Geodesy **14 CP**	**Mathematics and Beyond (9 CP)**	Opt. **Supplementary Modules (0–4 CP)**	Compulsory **Remote Sensing Part 2** Computer Vision and Rem. Sensing Geoinformatics Remote Sensing of the Atmosphere Fundamentals of Environmental Geodesy **9 CP**	**Mathematics and Beyond (6 CP)**	Opt. Elective **Supplementary Modules (2–4 CP)**	Comp. **Lab Rotation 1 (10 CP)**	Opt. **Supplementary Modules (2–6 CP) and Key Competences (4 CP)**	Compulsory **Master Thesis (30 CP)**
2nd half of semester	Compulsory Elective **1 out of 6 Profiles** compulsory as well as compulsory elective modules (part 1) **5–10 CP**			Compulsory Elective **1 out of 6 Profiles** compulsory as well as compulsory elective modules (part 2) **10–15 CP**			**Lab Rotation 2 (10 CP)**		
Sum	**31–33**			**29–31**			**28**		**30**
Total	**120**								

Commencement of studies in the winter semester is recommended. However, there is no mandatory sequence for most modules, thus commencement in the summer semester is also possible.

2.4 Overview over the modules and examination modes

[1] Other courses in scientific programming offered at KIT can be selected. The Examination Commission decides about their eligibility.

Topic: **Remote Sensing**			
Module		CP	Examination Mode
RSGI-MRCR	Computer Vision and Remote Sensing	8	oral, graded
RSGI-MRGI	Geoinformatics	5	oral, graded
RSGI-MRRA	Remote Sensing of the Atmosphere	5	oral, graded
RSGI-MRFE	Fundamentals of Environmental Geodesy	5	other, graded

Topic: **Mathematics and Beyond**			
Module		CP	Examination Mode
RSGI-MMCM-1	Numerical Mathematics	6	written, graded
RSGI-MMCM-2	Basics of Estimation Theory and its Application in Geoscience Remote Sensing Projects	6	oral, graded
In the following modules imported compulsory selected modules a total of 3 or more CPs have to be acquired.			
RSGI-MMCE-1	Introduction to Matlab	3	course achievement
RSGI-MMCE-2	Dummy[1]	3	TBD
RSGI-MMCE-3	Dummy[1]	3	TBD

Topic: **Profiles** (Choice of 1 out of 6)			
Module		CP	Examination Mode
1. Computer Vision and Geoinformatics	2 compulsory modules plus ~ 3 compulsory elective modules	20	see module description
2. Computer Vision and Remote Sensing of the Atmosphere	2 compulsory modules plus ~ 3 compulsory elective	20	see module description
3. Computer Vision and Environmental Geodesy	2 compulsory modules plus ~ 4 compulsory elective	20	see module description
4. Geoinformatics and Remote Sensing of the Atmosphere	2 compulsory modules plus ~ 3 compulsory elective	20	see module description
5. Geoinformatics and and Environmental Geodesy	2 compulsory modules plus ~ 3 compulsory elective	20	see module description
6. Remote Sensing of the Atmosphere and Environmental Geodesy	2 compulsory modules plus ~ 3 compulsory elective	20	see module description

In each profile, the required number of CPs is 10 for compulsory modules and 10 for compulsory elective modules.

Topic: **Supplementary Modules**			
Module		CP	Examination Mode
Choice of modules summing up to 8 CP	$\sim 2 - -4$ elective modules	8	see module description

Topic: **Key Competences**			
Module		CP	Examination Mode
Choice of modules summing up to 4 CP	~ 2 elective modules	4	see module description

Topic: **Lab Rotation**			
Module		CP	Examination Mode
Choice of 2 Lab Rotations	2×10 CP	20	other

Topic: **Master Thesis**			
Module		CP	Examination Mode
Master Thesis	6 months	30	other

Total: 120 CP

Chapter 3

Qualification Targets of the Program

General Issues

Goals of qualification generally describe

- the subject-specific and overarching competences which students can acquire in this program
- which learning outcomes can/should be achieved during the studies in this program. These learning outcomes are specified on three levels. First on the level of the master program, and then on the levels of modules and courses. They describe competences and testable learning outcomes.

Subject-specific competences are related to fundamental as well as specific knowledge and understanding with respect to methods, tenets, concepts and working approachs in the field of remote sensing and geoinformatics. Overarching competences are basic as well as specific competences which are applicable in multiple fields and disciplines and whic do not depend on a specific subject. Typical examples are soft-skills like the capacity for teamwork, the ability of networked thinking, communication skills and so forth.

Learning outcomes describe the success of the learning/studying which is testable by examinations and allow to determin the level up to which the competence has been formed and developed during the studies.

3.1 Qualification Targets of the master program Remote Sensing and Geoinformatics

In this master program the scientific qualification acquired in related bachelor programs are deepened and complemented. The goal of this program is to convey the ability to independently apply scientific knowledge and methods and to evaluate their implications and relevance to the solution of complex scientific problems.

The degree holders of the master program Remote Sensing and Geoinformatics have well-founded knowledge in current and future-oriented technologies and methods related to the processing and analysis of spatially and temporally resolved geoscientific and remotely sensed data. They have detailed technical and methodical knowledge in remote sensing and geoinformatics and have in-depth insight into selected professional fields for remote sensing scientists and geo-information scientists. Based on broad basic knowledge they have the ability to identify, characterize and elaborate future scientific and technical key questions with innovation potential in the given subject area. They have actively developed the ability to methodically explore knowledge sources are thus capable to acquaint themselves with advanced research problems.

They have the comprehensive ability to autonomously analyze and evaluate tasks in the field of remote sensing and geoinformatics and to implement related practical solutions. They can, under condideration of a particular situation, select the adequate methods, apply them in a targeted and problem-solving fashion, and to evaluate them critically. They have the ability to put the knowledge gained to work both in their own field as well as in an interdisciplinary context. The degree holders have proven to be able to collect and pre-select all relevant information, particularly in complex situations, to analyze and evaluate this information, to process, characterize, document, visualize relevant data and to present results in a compelling manner. They can familiarize themselves independently with current research topics and complex problems and thoroughly analyze, interpret and evaluate them. They have the ability to autonomously develop and implement concepts to tackle problems they have identified and analyzed. They classify subject-specific and interdisciplinary tasks and identify, or, if need be, develop, adequate methods of measurement, data analysis and processing as well as data characterization.

They are able to extensively document, complile, illustrate and interpret results in a targeted manner. They have the ability to work both independently or in a team and can take leadership in interdisciplinary projects. They can thoroughly explore technical literature in English language, bring forward their argument and defend their stance in topical discussions both with specialists and laypersons in adequate language. In the application of their topic-related knowledge they consider societal, scientific, and ethical issues.

The qualification targets of the master program Remote Sensing and Geoinformatics are summarized in the following table in a structured manner. Then follow the qualification targets and learning outcomes on module and course levels.

The following abbreviations are used:
DQR: Deutscher Qualifikationsrahmen
QZ-Nr: Qualifikationszielnummer

DQR	QZ-Nr.	Qualification targets on program level	Module
Subject-specific competences "Knowledge and Understanding"			
Subject-specific competence: broadening of knowledge	1	The degree holder has profound knowledge in current and future-oriented techniques and methods for processing, characterization and analysis of spatially and temporally resolved geoscientific and remotely sensed data	all
	2	The student has detailed technical and methodical knowledge in remote sensing and geo-informatics and has in-depth insight into selected professional fields for remote sensing scientists and geo-information scientists.	all
Subject-specific competence: deepening of knowledge	3	Based on broad basic knowledge the degree holder can identify, describe and tackle advanced scientific questions with innovation potential in the given subject area	all, particularly modules of the profiles
	4	The student has actively developed the ability to methodically explore knowledge sources, is thus capable to acquaint themselves with advanced reserach problems.	all seminars; lab rotation; master thesis
Instrumental competence	5	The student has the comprehensive ability to autonomously analyze and	lab rotations master thesis

		evaluate tasks in the field of remote sensing and geoinformatics and to implement related practical solutions.	
	6	The student can, under condideration of a particular situation, select the adequate methods, apply them in a targeted and problem-solving fashion, and evaluate them critically.	seminars lab rotations Master thesis
	7	The student has the ability to put the knowledge gained to work both in their own field as well as in an interdisciplinary context.	all
System Competence	8	The degree holder has proven to be able to collect and pre-select all relevant information, particularly in complex situations, to analyze and evaluate this information, to process, characterize, document, visualize relevant data and to present results in a compelling manner.	all, particularly seminars
	9	The student can familiarize herself independently with current research topics and complex problems and thoroughly analyze, interpret and evaluate them.	seminars lab rotations master thesis
	10	The student has the ability to autonomously develop and implement concepts to tackle problems they have identified and analyzed.	seminars lab rotations master thesis
	11	The student classifies subject-specific and interdisciplinary tasks and identifies, or, if need be, develops, adequate methods of measurement, data analysis and processing as well as data characterization.	lab rotation master thesis
	12	The student is able to extensively document, complile, illustrate and interpret results in a targeted manner.	seminars lab rotation Scientific Writing Master Thesis
	13	In the application of the topical knowledge the student considers societal, scientific and ethical issues.	all
Communication skills	14	The student has the ability to work both independently or in a team and can take leadership in interdisciplinary projects.	projects lab rotation master thesis
	15	The student can thoroughly explore technical literature in the English language	all
	16	The student has the ability to bring forward their argument and defend their stance in topical discussions both with specialists and laypersons in adequate language.	seminars

Chapter 4

Overview Over the Courses of the Modules and Modes of Examination

4.1 Remote Sensing

All modules are compulsory								
RSGI-M-R								
Module	Course No	Course	Sem.	Contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
Computer Vision and Remote Sensing RSGI-MRCR	6048101/ 604810	Methods of Remote Sensing	WS	1+1	3	Yes: Successful Participation In Exercise	oral ∼40 min.	GuG
	6042101	Image Processing and Computer Vision	WS	1+1	3	No		GuG
	6042202	Sensors and Signals in Computer Vision and Remote Sensing	SS	2+0	2	No		GuG
Geo-informatics RSGI-MRGI	6022105/ 6022106	Geoinformatics Part A	WS	1+1	2.5	No	oral ∼30 min.	GuG
	6022205/ 6022206	Geoinformatics Part B	SS	1+1	2.5	No		GuG
Remote Sensing of the Atmosphere RSGI-MRRA		Remote Sensing of a Changing Climate	WS	2+1	3	No	oral ∼20 min.	GuG
		Atmospheric Remote Sensing Infrastructures	SS	1	2			GuG
Fundamentals of Environmental Geodesy RSGI-MRFE		Fundamentals of Environmental Geodesy Part A	WS	1+1	2.5	No	other	GuG
		Fundamentals of Environmental Geodesy Part B	SS	1+1	2.5	No		GuG

4.2 Mathematics and Beyond

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
All modules are compulsory; particular courses within 'Scientific Programming' are elective								
RSGI-M-R								
Numerical Mathematics RSGI-MMNM	60621101/ 60622102	Numerical Mathematics	WS	3+1	6	yes	written exam. 120 min.	GuG
Basics of Estimation Theory and its Application in Geosecience Remote Sensing RSGI-MMET		Basics of Estimation Theory	SS	1+1	3	yes	oral exam ∼30 min.	GuG
		Data Analysis in Geoscience Remote Sensing Projects	SS	1+2	3	yes		GuG
Scientific Programming RSGI-MMSP	CC772	Introduction to Matlab	WS	2	3	no	course achievement	Wat Sci
	dummy							

4.3 Profile Courses

1 out of 6 profile has to be selected (Each of the 6 profiles ia actually a combination of 2 out of 4 sub-profiles).

4.3.1 Profile: Computer Vision and Geoinformatics

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
RSGI-M-P-CV								
Compulsory Modules								
Advanced Topics in Computer Vision RSGI-MPCV-1		Advanced Topics in Computer Vision Vision	WS	2+2	5	no	oral exam ∼ 20 min	GuG (Hinz)
GeoDB RSGI-MPGI-1 (=GEOD-MPGI-1 /PNR 10823)	6026101/ 6026102	GeoDB	WS	2+1	5	yes	oral exam. ∼ 20 min.	GuG (Breunig)
Compulsory Elective Modules								
Seminar Topics of Image Analysis RSGI-MPCV-2	6048103	Seminar Topics of Image Analysis	WS	1+0	2	no	oral exam ∼ 20 min	GuG (Hinz)

(=GEOD-MWEB-1 /PNR 10788)								
Active Sensors for Computer Vision I,II RSGI-MPCV-3 (=GEOD-MWCV-3 /PNR 10760)	6043205	Active Sensors for Computer Vision I,II	SS	2+0	3	no	oral exam $\sim$ 20 min	GuG (Hinz)
Tomographic Laser- and Radar Sensing I,V RSGI-MPCV-4 (=GEOD-MWCV-8 /PNR 10786)	6043212/ 6043213	Tomographic Laser- and Radar Sensing I,V	SS	1+1	3	Yes: Successful Participation In Exercise	oral exam $\sim$ 20 min	GuG (Hinz)
Augmented Reality RSGI-MPCV-5 (=GEOD-MWGI-8 /PNR 10778)	6046103/ 6046104	Augmented Reality	WS	1+2	4	Yes: Successful Participation In Exercise	oral exam $\sim$ 20 min	GuG (Hinz)
Advanced Analysis in GIS RSGI-MPGI-2 (=GEOD-MPEA-3 PNR 10782)	6027201	Advanced Analysis in GIS	SS	2+0	3	no	oral exam. ~ 20 min.	GuG (Breunig)
Advanced MAP Projections RSGI-MPGI-3 (=GEOD-MWEA-2 /PNR 10831	6027101/ 6027102	Advanced MAP Projections	WS	1+1	3	yes	oral exam. ~ 20 min.	GuG (Breunig)
3D/4D GIS RSGI-MPGI-4 (=GEOD-MPGI-2 /PNR 10830)	6026201/ 6026202	3D-4D GIS	SS	2+1	4	yes	oral exam. ~ 20 min.	GuG (Breunig)
Mobile GIS RSGI-MPGI-5 (=GEOD-MWGI-2 /PNR 10773)	6026206/ 6026207	Mobile GIS	SS	1+1	3	yes	oral exam. ~ 20 min. exam.	GuG (Breunig)
Place holder 1							graded	
Place holder 2							graded	
Place holder 3							graded	
Place holder 4							not graded	
Place holder 5							not graded	
Place holder 6							not graded	

4.3.2 Profile: Computer Vision and Remote Sensing of the Atmosphere

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
RSGI-M-P-CV								
Compulsory Modules								
Advanced Topics in Computer Vision RSGI-MPCV-1		Advanced Topics in Computer Vision Vision	WS	2+2	5	no	oral exam $\sim$ 20 min	GuG (Hinz)
Remote Sensing of Atmospheric Temperature, Trace Gases, Clouds and Aerosols RSGI-MPRA		Passive Remote Sensing of Atmospheric Temperature and Composition	WS	1.5+ 0.5	2	no	oral exam ~ 40 min.	GuG (von Clar- mann and Hase)
		Remote Sensing of Aerosols and Clouds	SS	1+1	3	no		GuG (Cer- mak)
Compulsory Elective Modules								
Seminar Topics of Image Analysis RSGI-MPCV-2 (=GEOD-MWEB-1 /PNR 10788)	6048103	Seminar Topics of Image Analysis	WS	1+0	2	no	oral exam $\sim$ 20 min	GuG (Hinz)
Active Sensors for Computer Vision I,II RSGI-MPCV-3 (=GEOD-MWCV-3 /PNR 10760)	6043205	Active Sensors for Computer Vision I,II	SS	2+0	3	no	oral exam $\sim$ 20 min	GuG (Hinz)
Tomographic Laser- and Radar Sensing I,V RSGI-MPCV-4 (=GEOD-MWCV-8 /PNR 10786)	6043212/ 6043213	Tomographic Laser- and Radar Sensing I,V	SS	1+1	3	Yes: Successful Participation In Exercise	oral exam $\sim$ 20 min	GuG (Hinz)
Augmented Reality RSGI-MPCV-5 (=GEOD-MWGI-8 /PNR 10778)	6046103/ 6046104	Augmented Reality	WS	1+2	4	Yes: Successful Participation In Exercise	oral exam $\sim$ 20 min	GuG (Hinz)
Atmospheric		Atmospheric	SS	2	2	no		GuG

Spectroscopy and Middle Atmospheric Research RSGI-MPRA-3		Spectro-scopic Measurements Measurements					oral exam. ~ 40 min.	(Hase)
		The Middle Atmosphere: Processes and Reserach Methods	SS	1	2	no		GuG (von Clar-mann)
Atmospheric Radiation RSGI-MPRA-4		Atmospheric Radiation	WS	2	2	no	oral exam. ~ 30 min.	GuG (Hase)
Place holder 1							graded	
Place holder 2							graded	
Place holder 3							graded	
Place holder 4							not graded	
Place holder 5							not graded	
Place holder 6							not graded	

4.3.3 Profile: Computer Vision and Environmental Geodesy

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
RSGI-M-P-CV								
Compulsory Modules								
Advanced Topics in Computer Vision RSGI-MPCV-1		Advanced Topics in Computer Vision Vision	WS	2+2	5	no	oral exam $\sim$ 20 min	GuG (Hinz)
Geodetic Earth Observation RSGI-MPEG		Mass Variations	WS	1+1	2	yes: successful participation in exercises and presentation in Seminar Earth Observation	oral exam. ~ 30 min.	GuG (Heck)
		Deformation Processes	SS	1+1	2			GuG (Heck)
		Seminar Earth Observation	WS	0+1	1		course achievement	GuG (Heck)
Compulsory Elective Modules								
Seminar Topics of Image Analysis RSGI-MPCV-2 (=GEOD-MWEB-1 /PNR 10788)	6048103	Seminar Topics of Image Analysis	WS	1+0	2	no	oral exam $\sim$ 20 min	GuG (Hinz)

Active Sensors for Computer Vision I,II RSGI-MPCV-3 (=GEOD-MWCV-3 /PNR 10760)	6043205	Active Sensors for Computer Vision I,II	SS	2+0	3	no	oral exam $\sim$ 20 min	GuG (Hinz)
Tomographic Laser- and Radar Sensing I,V RSGI-MPCV-4 (=GEOD-MWCV-8 /PNR 10786)	6043212/ 6043213	Tomographic Laser- and Radar Sensing I,V	SS	1+1	3	Yes: Successful Participation In Exercise	oral exam $\sim$ 20 min	GuG (Hinz)
Augmented Reality RSGI-MPCV-5 (=GEOD-MWGI-8 /PNR 10778)	6046103/ 6046104	Augmented Reality	WS	1+2	4	Yes: Successful Participation In Exercise	oral exam $\sim$ 20 min	GuG (Hinz)
Scientific GNSS Data Processing RSGI-MPEG-3 (=GEOD-MWGF-6 /PNR 10822)	6025209	Scientific GNSS Data Processing	SS	0+2	3	no	other	GuG (Heck)
Advanced Gravity Field Modeling RSGI-MPEG-4 (=GEOD-MWGF-2 /PNR 10849)		Global Gravity Field Modeling	WS	1+1	2+1	yes: successful participation in exercises	other	GuG (Heck)
SAR and InSAR Remote Sensing RSGI-MPEG-6 (=GEOD-MPGF-3 /PNR 10846)		SAR and InSAR Remote Sensing	SS	1+1	2+1	yes: successful participation in exercises	oral exam. $\sim$ 20 min.	GuG (Heck)
Geodetic Sensor Fusion RSGI-MPEG-7		Geodetic Sensor Fusion	WS	1+1	3	no	other	GuG (Heck)
Recent Earth Observation Programs and Systems RSGI-MPEG-8 (=GEOD-MPEB-1 together with methods of remote sensing	6048201/ 6048202 (imported)	Recent Earth Observation Programs and Systems	SS	1+0	2	no	oral exam. $\sim$ 30 min.	GuG (Hinz)

Hyperspectral Remote Sensing RSGI-MPEG-9 (=GEOD-MPEA-1 /PNR 10782)	6047101/ 6047102 (imported)	Hyperspectral Remote Sensing	WS	1+1	2+1	yes: successful participation in exercises	oral exam. ~ 20 min	GuG (Hinz)
Seminar Topics of Remote Sensing RSGI-MPEG-10 (=GEOD-MWEA-1 /PNR 10784)	6047203 (imported)	Seminar Topics of Remote Sensing	SS	1+0	2	no	oral exam. ~ 20 min	GuG (Hinz)
Place holder 1							graded	
Place holder 2							graded	
Place holder 3							graded	
Place holder 4							not graded	
Place holder 5							not graded	
Place holder 6							not graded	

4.3.4 Profile: Geoinformatics and Remote Sensing of the Atmosphere

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
RSGI-M-P-GI								
Compulsory Modules								
GeoDB RSGI-MPGI-1 (=GEOD-MPGI-1 /PNR 10823)	6026101/ 6026102	GeoDB	WS	2+1	5	yes	oral exam. ~ 20 min.	GuG (Breunig)
Remote Sensing of Atmospheric Temperature, Trace Gases, Clouds and Aerosols RSGI-MPRA		Passive Remote Sensing of Atmospheric Temperature and Composition	WS	1.5+ 0.5	2	no	oral exam ~ 40 min.	GuG (von Clarmann and Hase)
		Remote Sensing of Aerosols and Clouds	SS	1+1	3	no		GuG (Cermak)
Compulsory Elective Modules								
Advanced Analysis in GIS RSGI-MPGI-2 (=GEOD-MPEA-3 PNR 10782)	6027201	Advanced Analysis in GIS	SS	2+0	3	no	oral exam. ~ 20 min.	GuG (Breunig)

Advanced MAP Projections RSGI-MPGI-3 (=GEOD-MWEA-2 /PNR 10831	6027101/ 6027102	Advanced MAP Projections	WS	1+1	3	yes	oral exam. ~ 20 min.	GuG (Breunig)
3D/4D GIS RSGI-MPGI-4 (=GEOD-MPGI-2 /PNR 10830)	6026201/ 6026202	3D-4D GIS	SS	2+1	4	yes	oral exam. ~ 20 min.	GuG (Breunig)
Mobile GIS RSGI-MPGI-5 (=GEOD-MWGI-2 /PNR 10773)	6026206/ 6026207	Mobile GIS	SS	1+1	3	yes	oral exam. ~ 20 min.	GuG (Breunig)
Atmospheric Research Topics RSGI-MPRA-3		Atmospheric Spectroscopic Measurements	SS	2	2	no	oral exam. ~ 40 min.	GuG (Hase)
		The Middle Atmosphere: Processes and Reserach Methods	SS	1	2	no		GuG (von Clarmann)
Atmospheric Radiation RSGI-MPRA-4		Atmospheric Radiation	WS	2	2	no	oral exam. ~ 30 min.	GuG (Hase)
Place holder 1							graded	
Place holder 2							graded	
Place holder 3							graded	
Place holder 4							not graded	
Place holder 5							not graded	
Place holder 6							not graded	

4.3.5 Profile: Geoinformatics and Environmental Geodesy

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
RSGI-M-P-GI								
Compulsory Modules								
GeoDB RSGI-MPGI-1 (=GEOD-MPGI-1 /PNR 10823)	6026101/ 6026102	GeoDB	WS	2+1	5	yes	oral exam. ~ 20 min.	GuG (Breunig)
Geodetic Earth Observation RSGI-MPEG		Mass Variations	WS	1+1	2	yes: successful participation	oral exam. ~ 30 min.	GuG (Heck)
		Deformation Processes	SS	1+1	2	in exercises and presentation		GuG (Heck)

						in Seminar Earth Observation		
		Seminar Earth Observation	WS	0+1	1		course achievement	GuG (Heck)
Compulsory Elective Modules								
Advanced Analysis in GIS RSGI-MPGI-2 (=GEOD-MPEA-3 PNR 10782)	6027201	Advanced Analysis in GIS	SS	2+0	3	no	oral exam. ~ 20 min.	GuG (Breunig)
Advanced MAP Projections RSGI-MPGI-3 (=GEOD-MWEA-2 /PNR 10831	6027101/ 6027102	Advanced MAP Projections	WS	1+1	3	yes	oral exam. ~ 20 min.	GuG (Breunig)
3D/4D GIS RSGI-MPGI-4 (=GEOD-MPGI-2 /PNR 10830)	6026201/ 6026202	3D-4D GIS	SS	2+1	4	yes	oral exam. ~ 20 min.	GuG (Breunig)
Mobile GIS RSGI-MPGI-5 (=GEOD-MWGI-2 /PNR 10773)	6026206/ 6026207	Mobile GIS	SS	1+1	3	yes	oral exam. ~ 20 min.	GuG (Breunig)
Scientific GNSS Data Processing RSGI-MPEG-3 (=GEOD-MWGF-6 /PNR 10822)	6025209	Scientific GNSS Data Processing	SS	0+2	3	no	other	GuG (Heck)
Advanced Gravity Field Modeling RSGI-MPEG-4 (=GEOD-MWGF-2 /PNR 10849)		Global Gravity Field Modeling	WS	1+1	2+1	yes: successful participation in exercises	other	GuG (Heck)
SAR and InSAR Remote Sensing RSGI-MPEG-6 (=GEOD-MPGF-3 /PNR 10846)		SAR and InSAR Remote Sensing	SS	1+1	2+1	yes: successful participation in exercises	oral exam. ~ 20 min.	GuG (Heck)
Geodetic Sensor Fusion RSGI-MPEG-7		Geodetic Sensor Fusion	WS	1+1	3	no	other	GuG (Heck)
Recent Earth	6048201/ 6048202	Recent Earth	SS	1+0	2	no	oral exam.	GuG (Hinz)

Observation Programs and Systems RSGI-MPEG-8 (=GEOD-MPEB-1 together with methods of remote sensing	(imported)	Observation Programs and Systems					~ 30 min.	
Hyperspectral Remote Sensing RSGI-MPEG-9 (=GEOD-MPEA-1 /PNR 10782)	6047101/ 6047102 (imported)	Hyperspectral Remote Sensing	WS	1+1	2+1	yes: successful participation in exercises	oral exam. ~ 20 min	GuG (Hinz)
Seminar Topics of Remote Sensing RSGI-MPEG-10 (=GEOD-MWEA-1 /PNR 10784)	6047203 (imported)	Seminar Topics of Remote Sensing	SS	1+0	2	no	oral exam. ~ 20 min	GuG (Hinz)
Place holder 1							graded	
Place holder 2							graded	
Place holder 3							graded	
Place holder 4							not graded	
Place holder 5							not graded	
Place holder 6							not graded	

4.3.6 Profile: Remote Sensing of the Atmosphere and Environmental Geodesy

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
RSGI-M-P-RA								
Compulsory Modules								
Remote Sensing of Atmospheric Temperature, Trace Gases, Clouds and Aerosols RSGI-MPRA		Passive Remote Sensing of Atmospheric Temperature and Composition	WS	1.5+ 0.5	2	no	oral exam ~ 40 min.	GuG (von Clarmann and Hase)
		Remote Sensing of Aerosols and Clouds	SS	1+1	3	no		GuG (Cermak)
Geodetic Earth Observation		Mass Variations	WS	1+1	2	yes: successful participation	oral exam. ~ 30 min.	GuG (Heck)
		Deformation	SS	1+1	2	in exercises		GuG

RSGI-MPEG		Processes				and presentation in Seminar Earth Observation		(Heck)
		Seminar Earth Observation	WS	0+1	2		course achievement	GuG (Heck)
Compulsory Elective Modules								
Atmospheric Research Topics RSGI-MPRA-3		Atmospheric Spectro-scopic Measurements	SS	2	2	no	oral exam. ~ 40 min.	GuG (Hase)
		The Middle Atmosphere: Processes and Reserach Methods	SS	1	2	no		GuG (von Clar-mann)
Atmospheric Radiation RSGI-MPRA-4		Atmospheric Radiation	WS	2	2	no	oral exam. ~ 30 min.	GuG (Hase)
Scientific GNSS Data Processing RSGI-MPEG-3 (=GEOD-MWGF-6 /PNR 10822)	6025209	Scientific GNSS Data Processing	SS	0+2	3	no	other	GuG (Heck)
Advanced Gravity Field Modeling RSGI-MPEG-4 (=GEOD-MWGF-2 /PNR 10849)		Global Gravity Field Modeling	WS	1+1	2+1	yes: successful participation in exercises	other	GuG (Heck)
SAR and InSAR Remote Sensing RSGI-MPEG-6 (=GEOD-MPGF-3 /PNR 10846)		SAR and InSAR Remote Sensing	SS	1+1	2+1	yes: successful participation in exercises	oral exam. ~ 20 min.	GuG (Heck)
Geodetic Sensor Fusion RSGI-MPEG-7		Geodetic Sensor Fusion	WS	1+1	3	no	other	GuG (Heck)
Recent Earth Observation Programs and Systems RSGI-MPEG-8 (=GEOD-MPEB-1 together with methods of	6048201/ 6048202 (imported)	Recent Earth Observation Programs and Systems	SS	1+0	2	no	oral exam. ~ 30 min.	GuG (Hinz)

remote sensing								
Hyperspectral Remote Sensing RSGI-MPEG-9 (=GEOD-MPEA-1 /PNR 10782)	6047101/ 6047102 (imported)	Hyperspectral Remote Sensing	WS	1+1	2+1	yes: successful participation in exercises	oral exam. ~ 20 min	GuG (Hinz)
Seminar Topics of Remote Sensing RSGI-MPEG-10 (=GEOD-MWEA-1 /PNR 10784)	6047203 (imported)	Seminar Topics of Remote Sensing	SS	1+0	2	no	oral exam. ~ 20 min	GuG (Hinz)
Place holder 1							graded	
Place holder 2							graded	
Place holder 3							graded	
Place holder 4							not graded	
Place holder 5							not graded	
Place holder 6							not graded	

4.4 Supplementary Modules

4.4.1 Seminars

Each student shall sucessfully participate in at least one seminar. Those, who have no seminar in their profiles, can do this under "Supplementary Modules" as compulsory elective. The following seminars are eligible:

Seminars offered by other faculties may be eligible. Approvel by the examination commission is required.

4.4.2 Other

Supplementary moduels from any profile of this master program or the other master programs of the BGU faculty can be chosen. Modules from programs of other faculties or iternational summer/autumn/winter/spring schools can be chosen but need approval by the RSGI Examination Commission.

4.5 Lab Rotation

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
Lab Rotation 1 RSGI-ML-1		Lab Rotation 1	WS/ SS	4	8	45 CPs from compulsory or compulsory elective modules	course achievement	GuG
Lab Rotation 1 RSGI-ML-2		Lab Rotation 2	WS/ SS	4	8	45 CPs from compulsory or compulsory elective modules	course achievement	GuG

4.6 Key Competences

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
Scientific Writing RSGI-MASR		Scientific Writing	WS/ SS	1	2		other	HOC
Language Course		TBD	WS/ SS	TBD	TBD	TBD	TBD	

A language course is highly recommended (see Section 2.2.3). Further, micromodules offered by the House of Competence can be chosen. Choice to be approved by the RSGI Examination Commission.

4.7 Master Thesis

Module	Course No	Course	Sem.	contact hours	CP	Condition for Admission to Examination	Examination Type and Duration	Inst.
Master Thesis Writing RSGI-MASR		Master Thesis	WS/ SS		30	70 CPs (see SPO for details)	other	GuG

Chapter 5

Description of Topics and Modules

5.1 Remote Sensing 1/2

Module	**Computer Vision and Remote Sensing**
Code of module:	RSGI-MRCR
Coordinator of module:	Hinz/Weidner
Courses:	Course 1: Methods of Remote Sensing (3 CP) Course 2: Image Processing and Computer Vision (3 CP) Course 3 :Sensors and Signals in Computer Vision and Remote Sensing (2 CP)
Level:	4
Credit points:	8
Contact hours:	Course 1: 1L+1E Course 2: 2L+1E Course 3: 2L
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Remote Sensing; compulsory
Duration of module:	2 semester (WS+SS); examination after WS possible.
Exam:	The assessment consists of an oral exam (40 min.)
Particularities of exam:	Successfully completed exercises in Methods of Remote Sensing as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	**Course 1:** Students are able to explain the fundamentals of multispectral remote sensing, namely the basics of pixel- and segment-based classification approaches, their communalities and their differences. Students are able to use their knowledge and transfer it to other fields of applications. **Course 2:** Students are able to explain the fundamentals of image processing and computer vision. They describe the basic approaches and concepts including robust techniques and are able to use their knowledge and transfer it to other fields of applications. **Course 3:**

	Students reproduce the fundamentals of sensors and signals in Computer Vision and remote sensing. They describe the basic signal processing techniques. Students are able to use their knowledge and transfer it to other fields of applications.
Workload:	**Course 1**: **Total workload: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-Study: 60 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry **Course 2:** **Total workload: 90 hours** Contact hours: 45 hours - courses plus course-related examination Self-Study: 45 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - Preparation for exam **Course 3:** **Total workload: 60 hours** Contact hours: 30 hours courses plus course-related examination Self-Study: 45 hours consolidation of subject by recapitulation of lectures consolidation of subject by use of references and by own inquiry Preparation for exam **Total workload of all three courses: 240 hours**
Content:	**Course 1** This course provides an overview of multispectral remote sensing. It introduces to concepts of data processing, also including sensor aspects where required. Based on a selection of applications like land cover/used classification and change detection / monitoring approaches are presented and compared. The module consists of lectures and labs. **Course 2:** This course provides an overview of basic approaches of image processing and computer vision, starting from image filters like linear and non-linear filters, gradient and curvature operators and leading to concepts of object extraction based on point, line and segment extraction and their applications. The module consists of lectures and labs. **Course 3:**

	This course provides an overview on basic signal processing techniques: Mathematical principles, Systems and signals, Fourier-series, Delta function, Convolution, Fourier-Transformation, LTI-systems and modulation, Digital signal processing, Random Signals, Signal reconstruction, Interpolation, Multi-dimensional system theory.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Geoinformatics**
Code of module:	RSGI-MRGI (=GEOD-MAGI-2)
Coordinator of module:	Breunig
Courses:	Course 1: Geoinformatics (Part A) Course 2: Geoinformatics (Part B)
Level:	4
Credit points:	5
Contact hours:	1L+1E; 1L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Remote Sensing; compulsory
Duration of module:	2 semesters (WS+SS)
Exam:	The assessment consists of an oral exam (30 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	The students explain the fundamental concepts of Geoinformatics and their implementations, i.e .they penetrate them in theory and practice. Furthermore, they transform them to geo-applications. In particular, the structure and methods of geo-referenced data structures and algorithms are analyzed. The students transfer the learned content on advanced topics of Geoinformatics.
Workload:	**Total workload: 150 hours** Contact hours: 60 hours - courses plus course-related examination Self-Study: 90 hours - consolidation of subject by recapitulation of lectures - processing of exercises - consolidation of subject by use of references and by own inquiry Preparation for exam
Content:	The module provides students with an insight into concepts and practical methods of Geoinformatics based on geo-referenced data structures and algorithms, database systems, access methods, data models, software development, mobile information systems, etc.. In the practical part, the proposed methods are implemented in a programming language using relevant tools of Geoinformatics. Furthermore, in this module current research developments in Geoinformatics are discussed.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Remote Sensing of the Atmosphere**
Code of module:	RSGI-MRRA
Coordinator of module:	Jan Cermak
Courses:	Remote Sensing of a Changing Climate Atmospheric Remote Sensing Infrastructures
Level:	4
Credit points:	3+2
Contact hours:	(2L+1E)+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Remote Sensing; compulsory
Duration of module:	2 semesters (WS+SS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the exam.
Requirements:	—
Preconditions:	—
Recommendations:	Knowledge in geosciences/climate and statistics are helpful.
Objective:	Students explain the contribution of remote sensing to the assessment of climate change and its consequences in time and space. They relate how remote sensing assessments help further the understanding of processes driving global change. Students independently choose and apply methods and data sets suited for the analysis of specific aspects of global change.
Workload:	**Total workload: 160 hours** Contact hours: 55 hours - courses plus course-related examination - visits of atmospheric remote sensing infrastructures Self-study: 105 hours - consolidation of subject matters by recapitulation of lectures - consolidation of subject matters by use of references and by own inquiry - data analysis and data processing - preparations for exam
Content:	- Basics of global change: Mechanisms and patterns - Remote sensing approaches to analysing patterns of global change: o Land and ocean surface o Atmosphere - Remote sensing approaches to analysing mechanisms of global change o Land and ocean surface o Atmosphere - Links between remote sensing and other methods in global change research - Infrastructures and systems for atmospheric remote sensing
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Fundamentals of Environmental Geodesy**
Code of module:	RSGI-MRFE

Coordinator of module:	Heck (successor)
Courses:	-Fundamentals of Environmental Geodesy Part A -Fundamentals of Environmental Geodesy Part B
Level:	4
Credit points:	5
Contact hours:	1L+1E; 1L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Remote Sensing; compulsory
Duration of module:	2 semesters (WS+SS)
Exam:	The grade of the module consists (equally weighted) of the three assessments: Oral presentation (Part A), written scientific bulletin (Part B) and viva voce examination (20 minutes).
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	The students understand the basic principles of geodetic satellite missions. They know geodetic reference systems as well as the mathematical representation of the Earth's gravity field and are aware of their specific characteristics and research-related problems. The learners know the basic concepts of GNSS positioning and are able to familiarize themselves with new GNSS-related topics. They analyze real GOCE data and discuss the interactions of the various gravity satellite missions. The students work autonomous and self-organized in the field of environmental geodesy and have communicative as well as organizational competences with respect to collaboration, presentation and discussion. The students understand how geodetic and geo-scientific observation systems and techniques contribute to environmental geodesy.
Workload:	**Total workload Course 1: 90 hours** Contact hours: 21 hours - course plus course-related examination Self-study: 69 hours - consolidation of subject by recapitulation of lectures - processing of exercises - consolidation of subject by use of references and by own inquiry - exercises and presentations - preparations for viva voce examination **Total workload Course 2: 90 hours** Contact hours: 21 hours - Course plus course-related examination Self-study: 69 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - preparations for the viva vove examination **Total workload of both courses: 180 hours**
Content:	The courses 1 and 2 focus on the role of geodetic observation systems in environmental geodesy. **Course 1:**

	- Theoretical basics and research as well as praxis orientated principles of important satellite missions like GNSS, VLBI, SLR, DORIS; - Geodetic reference frames and systems, plate tectonics; - GNSS positioning; - InSAR; **Course 2:** - Mathematical representation of the gravity field of the Earth as well as its fundamental characteristics; - Geodetic gravity missions like Grace, GOCE, ICEsat; - Orbit parameters, resolution, accuracy;
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.2 Mathematics and Beyond

Module	**Numerical Mathematics**
Code of module:	RSGI-MMCM-1 (=GEOD-MANM-2)
Coordinator of module:	Bradley
Courses:	Numerical Mathematics
Level:	4
Credit points:	6
Contact hours:	3L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Compulsory Module
Duration of module:	1 semester (WS)
Exam:	The assessment consists of a written exam (120 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	Students can explain the basics of numerical mathematics as well as name and apply basic numerical methods.
Workload:	**Total workload: 180 hours** Contact hours: 60 hours - courses plus course-related examination Self-study: 120 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - preparations for exam
Content:	This module provides an overview of basic numerical methods like solving equations, interpolation, numerical linear algebra, approximation, and numerical integration. The module consists of lectures and exercise sessions.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Basics of Estimation Theory and its Application in Geoscience Remote Sensing**
Code of module:	RSGI-MMCM-2 (=GEOD-MASD-2)
Coordinator of module:	Hinz, Cermak
Courses:	Basics of Estimation Theory; Data Analysis in Geoscience Remote Sensing Projects;
Level:	4
Credit points:	6
Contact hours:	Course 1: 1+1 Course 2: 1+2
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Basic Subject, compulsory
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an oral exam (30 min.)
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.

Requirements:	—
Preconditions:	—
Recommendations:	Knowledge in statistics, parameter estimation and numerical mathematics are helpful.
Objective:	Students explain the theoretical basics and important aspects of detection, classification and parameter estimation. They apply the concepts and methods of estimation theory and deformation analysis to data recorded by geodetic, geophysical or remote sensing sensors. An even deeper understanding of the subjects is reached by home work and by working in a practical monitoring project. The students process the collected project data and evaluate the obtained results critically. By working self-organized and reflectively the students deepen their knowledge in soft skills, e.g. organization, collaboration and communication.
Workload:	**Total workload: 180 hours** Contact hours: 75 hours - courses plus course-related examination - field work in the monitoring project Self-study: 105 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - preparation of the monitoring project - data analysis and data processing - preparations for exam
Content:	Contents of the module include - an introduction into stochastic modelling (starting with the Bayes-Theorem) - theoretical models and applied methods of detection of events in signals. - theoretical models and applied methods of classification of events in signals. - a variety of methods for parameter estimation, e.g. least-squares estimation, transformation of probability density and integration of a-priori knowledge about parameters and observations - an introduction into the different statistical based methods of deformation analysis The theoretical aspects are applied to best-practise examples during labs and by working in a practical monitoring project.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Scientific Programming**
Code of module:	RSGI-MMCE-1
Coordinator of module:	See description of the exporting institution
Courses:	Introduction to Matlab (CC772 in WatSci) or any other course in scientific programming offered by KIT; the Examination Commission decides about eligibility.
Level:	4
Credit points:	3

Contact hours:	typically 2; depending on the particular course.
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Mathematics and Beyond
Duration of module:	1 semester
Exam:	typically course achievement; depending on the particular course.
Particularities of exam:	–
Grade of module:	not graded
Requirements:	—
Preconditions:	—
Recommendations:	It is recommended to select a programming language which is actually used in the groups where lab rotation or master thesis in made, if such courses are available.
Objective:	Ability to program sceintific algorithms in a selected programming language
Workload:	see description of the exporting institution
Content:	see description of the exporting institution
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.3 Profile Courses

5.3.1 Sub-Profile: Computer Vision

Module	**Advanced Topics in Computer Vision**
Code of module:	RSGI-MPCV-1
Coordinator of module:	Hinz, Weinmann
Courses:	Advanced Topics in Computer Vision
Level:	4
Credit points:	3+2
Contact hours:	2L+2E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory - Computer Vision and Remote Sensing of the Atmosphere; compulsory - Computer Vision and Environmental Geodesy; compulsory
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—

Objective:	The students learn about advanced topics in computer vision that are also of great interest for a variety of applications in remote sensing. These topics include fundamentals on feature extraction, texture analysis, pattern recognition, segmentation, object detection, object tracking, mosaicking, 3D reconstruction, scene analysis, building modeling and change detection. With this lecture, the students are also aware of recent challenges in machine learning and have an overview reaching from traditional classification approaches to modern deep learning techniques.
Workload:	**Total Workload: 150 hours** Contact hours: 60 hours - courses plus course-related examination - presentations Self-study: 90 hours - consolidation of subject by recapitulation of lectures - consolidation and preparation of subject by use of references and by own inquiry - preparations for exam
Content:	This module addresses a variety of advanced topics in computer vision: feature extraction (e.g. shape, texture and local features), texture analysis (e.g. co-occurrence matrix, Laws filter and Gabor filter), pattern recognition (feature matching), segmentation (e.g. watershed transformation, mean-shift segmentation, and normalized cuts), object detection (e.g. cars, road networks or people), object tracking (e.g. cars or people), mosaicking (e.g. creation of aerial mosaic images), 3D reconstruction (e.g. city models), scene analysis (e.g. 3D scene interpretation), change detection (e.g. land-cover and land-use monitoring) and machine learning (e.g. traditional classification approaches and deep learning techniques).
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Seminar Topics of Image Analysis**
Code of module:	RSGI-MPCV-2 (=GEOD-MWEB-1)
Coordinator of module:	Hinz
Courses:	Seminar Topics of Image Analysis
Level:	4
Credit points:	2
Contact hours:	1L
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Computer Vision and Remote Sensing of the Atmosphere; compulsory elective - Computer Vision and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—

Recommendations:	—
Objective:	Students learn in the form of a seminar selected state-of-the-art topics of image analyses. These will vary from year to year. Overall goal of this seminar is to get an insight into ways of investigating, selecting and condensing scientific work of the computer vision community, and to prepare it in such a way that the other students will benefit from it.
Workload:	**Total workload: 60 hours** Contact hours: 15 hours - introductory courses plus course-related examination - presentations Self-study: 45 hours - consolidation of subject by recapitulation of introductory lectures - consolidation and preparation of subject by use of references and by own inquiry - preparations for exam
Content:	Contents of the module include - introduction into selected topic - overview of boards, conferences, journals, books and the general structure of the image analysis and computer vision community - investigating and selecting important literature - condensing the nucleus of the respective topic - preparing hand-out and oral presentation
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Active Sensors for Computer Vision**
Code of module:	RSGI-MPCV-3 (=GEOD-MWEB-3)
Coordinator of module:	Jutzi
Courses:	Active Sensors for Computer Vision
Level:	4
Credit points:	3
Contact hours:	SS: 2L
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Computer Vision and Remote Sensing of the Atmosphere; compulsory elective - Computer Vision and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—

Objective:	Students reproduce the fundamentals of active sensing in Computer Vision. They describe the basic vision processing techniques. Students are able to use their knowledge and transfer it to other fields of applications.
Workload:	**Total workload: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-study: 60 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - preparations for exam
Content:	This module provides an overview on basic vision processing techniques: introduction to active sensing, measurement technique (atmosphere, navigation, puls-CW, surface & LASER beam), laser-scanning (Full-Waveform, quality aspects & system), range imaging (function & systems), triangulation procedures, data pre-processing (registration of point clouds, image-based registration (SIFT)), analyses of point clouds(model and daten-driven approaches, plane detection, RANSAC, building modeling), applications.
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

Module	**Tomographic Laser- and Radar Sensing**
Code of module:	RSGI-MPCV-4 (=GEOD-MWCV-8)
Coordinator of module:	Jutzi
Courses:	Tomographic Laser- and Radar Sensing
Level:	4
Credit points:	3
Contact hours:	1L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Computer Vision and Remote Sensing of the Atmosphere; compulsory elective - Computer Vision and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—

Objective:	Students learn the basics of tomography applied to remote sensing data. The overall goal is to understand how (quasi-)volumetric scattering can be reconstructed from remote sensing data. Special focus is put on advanced processing of Synthetic Aperture Radar (SAR) data and multi-echo or full waveform Laser data applied to tasks like automatic object characterization, atmospheric sounding and forest parameter estimation.
Workload:	**Total workload: 90 hours** Contact hours: 30 hours - introductory courses plus course-related examination - presentations Self-study: 60 hours - consolidation of subject by recapitulation of lectures - consolidation of preparation of subject by use of references and by own inquiry - preparations for exam
Content:	Contents of the module include: - introduction into tomography - SAR-Tomography - GNSS-Tomography - Full waveform Laserscanning - 3D atmospheric sounding The theoretical aspects are applied to best-practise examples during labs and home work.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Augmented Reality**
Code of module:	RSGI-MPCV-5 (=GEOD-MWGI-8)
Coordinator of module:	Hinz, Wursthorn
Courses:	Augmented Reality
Level:	4
Credit points:	4
Contact hours:	WS: 1L+2E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Computer Vision and Remote Sensing of the Atmosphere; compulsory elective - Computer Vision and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	The students reflect and deepen their previous knowledge of positioning, orientation, photogrammetry und geo information systems in the field of augmented reality.

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 - consolidation of preparation of subject by use of references and by own inquiry - preparations for exam
Content:	Selection of augmented reality applications in science, industry and entertainment. Sensors and technologies for positioning und orientation. Display technologies like glasses and projectors. User interaction in augmented reality.
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language:	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

5.3.2 Sub-Profile: Geoinformatics

Module	**GEODB**
Code of module:	RSGI-MPGI-1 (=GEOD-MPGI-1)
Coordinator of module:	Breunig
Courses:	GEODB
Level:	4
Credit points:	5
Contact hours:	2L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory - Geoinformatics and Remote Sensing of the Atmosphere; compulsory - Geoinformatics and Environmental Geodesy; compulsory
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	Knowledge in database systems
Objective:	The students explain the basic concepts of spatial data management. They are able to analyze object-oriented spatial data models, the structure and algorithms of spatial access methods. They know how to use geo-database management systems in theory and in practice. They are able to apply the mediated concepts and implementations to related problems. The students are able to transfer the learned knowledge to advanced topics such as 3D geo-databases.
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
Content:	The module provides students with an insight into the essential concepts and the state of the art in geo-data management. Standardized geospatial data models are introduced. The effect of multi-dimensional indexing of spatial data is explained and the structure and algorithms of specific spatial access methods are explained (e.g. quadtree, grid files, R trees, Generalized Search Tree). The theoretical aspects are implemented in practical exercises, for example, using object-relational spatial database systems (e.g PostGIS). Finally, reference is made to more advanced topics (e.g. topological databases) and current research in the field of geo-databases.
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

Module	**Advanced Analysis in GIS**
Code of module:	RSGI-MPGI-2 (=GEOD-MPEA-3)
Coordinator of module:	Breunig
Courses:	Advanced Analysis in GIS
Level:	4
Credit points:	3
Contact hours:	2L
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Geoinformatics and Remote Sensing of the Atmosphere; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an oral exam (20 min.).
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	The students get familiar with the advanced concepts of spatial analysis and 2D interpolation procedures. Especially the different aspects of statistical reasoning are analyzed. They can categorize all analysis problems with spatial background and estimate possible solutions.
Workload:	**Total workload: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-study: 60 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
Content:	After an introduction to analysis in GIS in general, this lecture is dealing with the specific approaches of statistical analysis of spatial data. Among them, in particular, the different methods of pattern analysis. This also encompasses the test strategies inherent to the aforementioned methods. Another topic is data mining, which is introduced as an extension of the point pattern analysis. Furthermore the 2D interpolation procedures are discussed (e. g. Natural Neighbor Interpolation, Kriging, ...).
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Advanced Map Projections**
Code of module:	RSGI-MPGI-3 (=GEOD-MWEA-2)
Coordinator of module:	Breunig
Courses:	Advanced Map Projections
Level:	4
Credit points:	3
Contact hours:	1L+1E

Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Geoinformatics and Remote Sensing of the Atmosphere; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.).
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	The participants get a deeper understanding of the projection problem in general. On the one hand this affects the invariants of the projection and on the other hand the term distortion needs a modified definition, which leads to the global distortion of small scale maps.
Workload:	**Total workload: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-study: 60 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
Content:	The advanced methods of map projections are discussed. This especially focusses parameter systems on the projection surface which are not perpendicular. There even is not assumed a strict mathematical relation — in the sense of rigorous projection equations — between the two surfaces (see: Robinson projection). Also the invariants are outlined (e. g. equal area). In addition different possibilities to describe the distortion of finite areas are presented (e.g. approach of Canters).
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**3D/4D GIS**
Code of module:	RSGI-MPGI-4 (=GEOD-MPGI-2)
Coordinator of module:	Breunig
Courses:	3D/4D GIS
Level:	4
Credit points:	4
Contact hours:	2L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Geoinformatics and Remote Sensing of the Atmosphere; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)

Exam:	The assessment consists of an oral exam (20 min.).
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	Knowledge in GIS and object-oriented programing
Objective:	The students explain the problems of space and time-related issues for the development and application of 3D/4D geoinformation systems. They are able to analyze spatio-temporal extensions to existing geometric and topological data models, spatial data standards, spatial databases and geographic information systems and develop them by themselves. In particular, the students are able to devise solutions for space-and time-related issues by their own and implement them in a programing language. They are able to transfer the learned knowledge to new spatio-temporal applications.
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
Content:	In the module relevant spatio-temporal concepts and implementations are presented for 3D/4D geoinformation systems. This concerns for example the geometric and topological data modeling, geo-data standardization, geo-data management and geo-data analysis. The concepts are considered with reference to 3D/4D geo-scientific applications. Furthermore, current research issues in the field of 3D/4D geoinformation systems are discussed. Finally, the introduced concepts are engrossed in programming exercises in the practical part of the module.
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

Module	**Mobile GIS**
Code of module:	RSGI-MPGI-5 (=GEOD-MWGI-2)
Coordinator of module:	Breunig
Courses:	Mobile GIS
Level:	4
Credit points:	3
Contact hours:	1L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Geoinformatics and Remote Sensing of the Atmosphere; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective

Duration of module:	1 semester (SS)
Exam:	oral exam. (20 min.).
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	The students explain the basics and possibilities of communication and positioning for registration of geodata with mobile instruments. In practical application they can register geodata with various hardware, administer it in a mobile database and synchronize with a central database. Further the students are able to develop an exemplar LBS application.
Workload:	**Total workload: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-study: 60 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
Content:	In the course of this lecture basics and possibilities of communication and positioning for registration of geodata with mobile hardware will be presented. These techniques are applied in practice to register geodata with various hardware, to administer them in a mobile database and to synchronize with a central database. Further, the students have the opportunity to get acquainted with the exemplary development of an LBS application and to apply this in practice.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.3.3 Sub-Profile: Remote Sensing of the Atmosphere

Module	**Remote Sensing of Atmospheric Temperature, Trace Gases, Clouds and Aerosols**
Code of module:	RSGI-MPRA
Coordinator of module:	Jan Cermak/Thomas von Clarmann
Courses:	Course 1: Passive Remote Sensing of Atmospheric Temperature and Composition Course 2: Remote Sensing of Aerosols and Clouds
Level:	4
Credit points:	5
Contact hours:	Course 1: 1.5L+0.5E Course 2: 2E (seminar)
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Remote Sensing of the Atmosphere; compulsory - Geoinformatics and Remote Sensing of the Atmosphere; compulsory

	- Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory
Duration of module:	2 semesters (WS+SS)
Exam:	The assessment consists of an oral exam (30 min.).
Particularities of exam:	Successful completion of exercise of course 2 is a requirement for exam
Grade of module:	The grade of the module is the grade of oral exam.
Requirements:	–
Preconditions:	–
Recommendations:	Basics of physics and basics of matrix algebra are required. Knowledge in geosciences/climate and statistics are helpful.
Objective:	**Course 1:** The students can explain the basics of passive remote sensing of atmospheric temperature and composition and the underlying radiative transfer principles. They know the advantages and drawbacks of different observation geometries, frequency ranges, and technical realizations. They know the common methods of data analysis and data characterization. Knowledge of the technical terminology enables them to read technical literature, to participate in related discussions and to prepare a master thesis in this field. **Course 2:** Students explain techniques used in remote sensing of aerosols and clouds, and their specific advantages. They relate how remote sensing assessments help improve the understanding of processes involving aerosols and clouds. Students independently choose and apply methods and data sets suited for the analysis of aerosols and clouds.
Workload:	**Total workload course 1: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-study: 60 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 **Total workload course 2: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-study: 60 hours - consolidation of subject by preparation of presentations - consolidation of subject by use of references and by own inquiry - processing of exercises - preparations for exam **Total workload of both courses: 180 hours**
Content:	**Course 1:**

	The use of remote sensing techniques for atmospheric measurements will be motivated. An introduction into the technical terminology is given. Measurement geometries (nadir, upward, limb, in emission and absorption) are presented and discussed. The fundamentals of radiative transfer will be recapitulated. Advantages and drawbacks of different spectral regions (UV, visible, infrared, microwave) are discussed. Exemplar satellite missions are presented. Data analysis by inverse methods applied to ill-posed problems is explained, as well as data characterization in terms of uncertainties and spatial resolution. Validation approaches are presented. An overview over career opportunities in this field is given. **Course 2:** - Passive-sensor remote sensing of aerosols - Passive-sensor remote sensing of clouds - Active-sensor remote sensing of aerosols - Active-sensor remote sensing of clouds - Assessment of cloud processes and aerosol-cloud interactions
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Atmospheric Spectroscopy and Middle Atmosphere Research**
Code of module:	RSGI-MPRA-3
Coordinator of module:	Thomas von Clarmann / Frank Hase
Courses:	Course 1: Atmospheric Spectroscopic Measurements Course 2: The Middle Atmosphere: Processes and Research Methods
Level:	4
Credit points:	Course 1: 2 Course 2: 2
Contact hours:	Course 1: 2L Course 2: 1L
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Remote Sensing of the Atmosphere; compulsory elective - Geoinformatics and Remote Sensing of the Atmosphere; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an oral exam (30 min.).
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	**Course 1:** Students discover the fundamentals of atmospheric remote sensing using spectrometric techniques. Strong emphasis is given to the technique of Fourier Transform Spectroscopy, a workhorse for infrared remote sensing of the atmosphere. **Course 2:**

	The students know the most relevant processes in the middle amosphere and how relted key parameters can be measured by remote sensing methods. Further, the students are familiar with related research methods, particular those involving inverse theory. They can explain the basic applications of inverse theory to atmospheric sciences; they are able to judge which method is adequate for which purpose.
Workload:	**Course 1:** **Total Workload: 60 hours** Contact hours: 30 hours Self study: 30 hours - recapitulation and consolidation by own study - preparation of exam **Course 2:** **Total workload: 60 hours** Contact hours: 20 hours - courses plus course-related examination Self-study: 40 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - preparations for exam **Total workload of both courses: 120 hours**
Content:	**Course 1:** - required fundamentals of electromagnetic theory and technical (/imaging) optics; spectroscopic tools: gratings, prisms, heterodyne techniques, interferometers; -Fourier transform spectroscopy: -Fourier transforms, useful relations; -Theory of the ideal Fourier spectrometer; -discrete sampling, FFT, and spectral data processing; -Non-ideal interferograms; -Effects of Noise; -Imaging Fourier spectrometer. **Course 2:** An introduction into stratospheric chemistry, the circulation of the middle atmosphere and radiative processes will be given. Remote sensing retrieval, data assimilation, source modelling and the direct inversion of the transport equation are identified as the typical applications of inverse techniques in atmospheric sciences. The mathematical structure of the problem and the interpretation of the variables is discussed in each of the applications. Examples from practical atmospheric sciences are presented.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Atmospheric Radiation**
Code of module:	RSGI-MPRA-4

Coordinator of module:	Frank Hase
Courses:	Atmospheric Radiation
Level:	4
Credit points:	2
Contact hours:	2L
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Remote Sensing of the Atmosphere; compulsory elective - Geoinformatics and Remote Sensing of the Atmosphere; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (30 min.).
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	—
Objective:	Students discover the underlying physics of and the astounding wealth of atmospheric radiation phenomena.
Workload:	**Total workload: 60 hours** Contact hours: 30 hours Self study: 30 hours - recapitulation and consolidation by own study - preparation of exam
Content:	- historical outline of radiation physics and optics; - recollection of electromagnetic theory, radiation variables; - black-body radiation, interaction of atoms and molecules with radiation; - radiation output of the Sun, composition of the terrestrial atmosphere; - radiative transfer; - optical phenomena in the atmosphere; - atmospheric radiation in different spectral regions; - radiation and the energy balance of the Earth; - remarks on atmospheric remote sensing.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.3.4 Sub-Profile: Environmental Geodesy

Module	**Geodetic Earth Observation**
Code of module:	RSGI-MPEG-1
Coordinator of module:	Westerhaus, Seitz
Courses:	Geodetic Earth Observation
Level:	4
Credit points:	5
Contact hours:	2L+1E
Degree program and	M. Sc. Remote Sensing and Geoinformatics

topic:	Profiles: - Computer Vision and Environmental Geodesy; compulsory - Geoinformatics and Environmental Geodesy; compulsory - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory
Duration of module:	2 semester (SS,WS)
Exam:	The assessment consists an oral exam (30 min.). Thereby both courses are weighted equally.
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam
Requirements:	—
Preconditions:	—
Recommendations:	Course 1: Fundamentals of Environmental Geodesy (Part B, Gravity field missions) Course 2: Fundamentals of Environmental Geodesy (Part A, Positioning)
Objective:	The students have a deepened knowledge about the mathematical representation of the gravity field of the Earth and its temporal variations. They know how to process and to analyze relevant data from GRACE mission and are familiar with fundamental methods to derive models for changing environmental parameters. The students understand active deformation processes of the 'rigid' Earth as a prominent source of changes in the Earth system. They know the special demands on measurement techniques and the basic methods to derive reliable estimations of surface displacements. 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 (e.g., sensing the atmosphere).
Workload:	**Total workload Course 1: 90 hours** Contact hours: 21 hours - courses plus course-related examination Self-study: 69 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 **Total workload Course 2: 90 hours** Contact hours: 21 hours - courses plus course-related examination Self-study: 69 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 **Total workload of both courses: 180 hours**
Content:	**Course 1**: - Investigation of temporal gravity variations as observed by GRACE - Derivation of mass variations in the Earth system - Geodetic contribution in the field of environmental changes with a

	focus on ground water storage - Accompanying methods like Radar altimetry **Course 2:** - Deformation processes of the Earth - Interseismic, coseismic and postseismic deformations at plate margins; - Anthropogenic surface displacements due to mining activites and fluid extraction; - Advanced methods of deformation measurements (e.g., SAR interferometry, GNSS)
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

Module	**Seminar Earth Observation**
Code of module:	RSGI-MPEG-2 (=GEOD-MPGF-2)
Coordinator of module:	Heck
Courses:	Seminar Earth Observation
Level:	4
Credit points:	1
Contact hours:	1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory - Geoinformatics and Environmental Geodesy; compulsory - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory
Duration of module:	1 semester (WS)
Exam:	other The assessment consists in the independent thorough scientific treatment of a recent research topic within the field of Earth system observation. Starting from a seminal article in a scientific journal the student acquires new topical competences and presents these in a didactically adequate manner, e.g. as an oral presentation of 20-25 minutes to the other students and the scientific staff. It follows a defense of the content of the presentation. Further, active participation in all seminar events of this module is compulsory (e.g., documented attendance at six presentations).
Particularities of exam:	–
Grade of module:	–
Requirements:	–
Preconditions:	—
Recommendations:	The students shall hold advanced knowledge in at least one topic (space-borne geodesy, physical geodesy, geodynamics).
Objective:	Subject-related competences: - The students describe fundamental recent concepts of Earth observation and are aware of the width this research field - The students are able to explore detailed technical literature with different foci, collect and structure the information provided, and are able to explain its content.

	- The students contribute to the learning outcome of the seminar group by subject-specific arguments. Inter-disciplinary competences: - The students are able to self-responsibly organize their and work to carry it out in an independent and selfcritical manner. - They have communication and organization skills in the fields of presentation and discussion. - The students are able to rate the presentation skills of other team members and can give and receive constructive criticism. - The students are able to understand and analyze technical literature in English language.
Workload:	**Total workload: 30 hours** Contact time: 6 hours During the contact hours individually selected topics will be explored and presented to the other students. Active participation in the seminars is compulsory. Self-study: 24 hours Independent and focused assessment of the content; preparation and presentation of a seminar talk including defense.
Content:	This course provides detailed and focused insight to the student in recent fields of Earth system observation. To achieve this, the students participate in a series of scientific seminars. The field of Earth system observation is of high current relevance, leading to a rapid change of the foci of research. This dynamical characteristic is accounted for and the most up-to-date issues find their way into the seminar which can vary from semester to semester. The topical focus will be agreed with the student and are of the field of global navigation satellite systems (GNSS), gravity field missions, and geodynamics (e.g. InSAR) with a special focus on environmental geodesy.
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language	In mutual agreement with the students the seminar will be held either in English of in German.

Module	**Scientific GNSS Data Processing**
Code of module:	RSGI-MPEG-3 (=GEOD-MWGF-6)
Coordinator of module:	Sumaya
Courses:	Scientific GNSS Data Processing
Level:	4
Credit points:	3
Contact hours:	2E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)

Exam:	The assessment consists of an assessment of success of other type according §4 para. 2 No. 3 SPO M.Sc. Geodäsie und Geoinformatik. The assessment is carried out according 4 para. 2 No. 3 SPO M.Sc. Geodäsie und Geoinformatik. The fundamental requirement for the assessment is the significant contribution to the project work carried out in the framework of the module. The project is conducted in teams (head count per team: max. 3). The assessment takes into account individual (in particular portfolio-based reflection) and team-related (in particular joint research project) achievements. The results of the project work have to be presented and discussed constructively (Audience: Academic staff).
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the assessment of success of other type.
Requirements:	—
Preconditions:	—
Recommendations:	
Objective:	Subject-related competencies: - The students are enabled to process GNSS data using scientific software (e.g., Bernese GNSS software) and to evaluate derived results. - The learners are aware of characteristics of scientific GNSS software, especially in contrast to non-scientific software resp. online services. Therefore, they are able to adequately choose problem-orientated the most suitable software. - The students are sensitized to datum-related GNSS aspects within scientific GNSS data processing (e.g. products, antenna modelling) and enabled to estimate their effects results-orientated. - The learners realize recent research related to scientific GNSS data processing within regional GNSS networks. Multi-disciplinary competencies: - The learners are enabled to work self-organized, independently and reflectively. They have a good command of communication and organization skills, especially related to collaboration, presentation and discussion. - The students recognize, re-order and explain complex GNSS contexts from a general perspective. - The learners handle, organize and analyze large data sets.
Workload:	**Total workload: 90 hours** Classroom lectures: 7,5 hours Taking the subject-related competencies of the students into account, in the beginning of the module the recent status of scientific GNSS data processing is presented in order to establish a fundamental basis for the project work. Self-study: 20 hours Taking the individual GNSS knowledge of the learners into account, scientific papers are used to deepen and advance the subject-related knowledge. Therefore, the students have to carry out individually - consolidation by recapitulation of lectures, - consolidation by use of references and by own inquiry. Project meetings: 4,5 hours

	During the project work, team meetings are regularly held in order to give status reports and discuss recent challenges. These meetings are of fundamental importance regarding scrutiny and systematic collaborative progress of the project. Project work: 58 hours The main workload is on the joint project dealing with a scientific question related to the scope of the module.
Content:	The main goal of this module is to generate deep insight into the processing of GNSS data of regional networks using scientific GNSS software. Therefore, basic fundamentals of geodetic datum in the context of products and antenna modelling are treated. The effects of selected modelling and processing strategies are analyzed in the coordinate domain with respect to strongly correlated parameters, such as tropospheric parameters.
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language:	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

Module	**Advanced Gravity Field Modelling**
Code of module:	RSGI-MPEG-4 (=GEOD-MWGF-4/PNR 10833)
Coordinator of module:	
Courses:	Global Gravity Field Modelling
Level:	4
Credit points:	
Contact hours:	
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the exam
Requirements:	—
Preconditions:	—
Recommendations:	Basics of Physical Geodesy. Profile: Any with the subprofile Environmental Geodesy Compulsory module: Geodetic Earth Observation RSGI-MPEG

Objective:	The students are able to describe the fields of application of highly precise regional modelling of the Earth's gravity field. They explain systems of local base functions used for representation of regional geoid or quasi-geoid models. The students are able to discuss the characteristics of the theories of Stokes and Molodenskii and the related height systems. They describe recent regional solutions of height reference surfaces in Europe. The students are able to explain the essential reductions which have to be applied to the observations according to the theory of Stokes, in terms of the vectorial as well as the scalar free variant. In this context they are able to describe standard modifications of the Stokes kernel function. The students explain the formulation of the geodetic boundary value problem starting from the non-linear boundary condition to linearization and several levels of approximation. The students are familiar with modern techniques within high-precision geoid and quasi-geoid determination (Remove-Compute-Restore Technique, Residual Terrain Modelling, combination of terrestrial gravity anomalies and geopotential models, high resolution DHM). The students have reflected the challenges within setting up the data basis and collecting different data types. When dealing with different data sources they are sensitized for the impact of various geodetic datums. The students are able to explain the fundamental differences between regional and global gravity field modelling.
Workload:	**Total workload: 90 hours** **Contact hours: 30 hours** - course plus course-related examination **Self-study: 60 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
Content:	This module provides advanced insight into the modelling of regional height reference surfaces of orthometric and normal heights. The respective theories of Stokes and Molodenskii are discussed considering their advantages and drawbacks. The reductions which have to be applied to the observations according to the theory of Stokes are presented and the respective hypotheses are explained. Different approaches of discretising topographic and isostatic masses are presented. The tesseroid-method, which was developed at the Geodetic Institute of the KIT, is presented in detail. Modifications of the Stokes function are explained. Their impact on the numerical solution of the disturbing potential is evaluated during a tutorial on this topic. The use of different types of gravity anomalies is discussed. Links to global gravity field modelling are pointed out. The mathematical formalism, on which the geodetic boundary value problem is based, will be explained in detail: non-linear boundary condition, linearization, explanation of several levels of approximation. Non-linear and ellipsoidal effects, as well as the impact of spherical approximation on the solution of the boundary value problem are quantified by the students within exercises. The challenge of data acquisition (digital elevation models, gravity values and anomalies, density models) is discussed. An insight into regional gravity field modelling is provided by presenting current research activities of the institute.

Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

Module	**SAR and InSAR Remote Sensing**
Code of module:	RSGI-MPEG-6 (=GEOD-MPGF-3)
Coordinator of module:	Westerhaus, Hinz
Courses:	SAR and InSAR Remote Sensing
Level:	4
Credit points:	3
Contact hours:	1L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an oral exam (20 min.).
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the exam
Requirements:	—
Preconditions:	—
Recommendations:	Basics of signal processing (Fourier-Transformation, digital filters)
Objective:	The students understand the basic concepts of SAR remote sensing as well as SAR interferometry. They explain important aspects of SAR image generation with special focus on synthetic aperture and signal focusing. They are familiar with the basics of the interferometric processing of SAR images with public domain tools like SNAP. They know important applications of SAR and are able to identify and interpret fundamental signatures caused by deformations of the Earth's surface or moving objects. The students know the different characteristics of frequency bands used by the three satellite based SAR systems (X-, C- and L-band) and assess their fields of application. They are familiar with the ordering procedure of SAR scenes via the ESA or TerraSAR-X archives. With this lecture, the learners acquire the necessary knowledge to conduct a SAR/InSAR project from the planning phase until the interpretation of results.
Workload:	**Total workload: 90 hours** Contact hours: 21 hours - course plus course-related examination Self-study: 69 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

Content:	The module delivers basic knowledge about the use of radar satellite imagery in the frame of Remote Sensing and Geodesy. The contents reach from technical aspects concerning image generation until the evaluation of results. Focus of the lectures and exercises is the whole processing chain, including signal focusing, interferometric processing and geocoding. Further emphasis is put on the "reading" of amplitude and phase images as well as the interpretation of different signal contributions. The theoretical concepts are accompanied by practical exercises with a total fraction of 50%, which foster the ability of the learners to process and visualize SAR data. Recent and former SAR missions whose data archives form the basis of most research- and application-orientated projects, are discussed. In the frame of a praxis-orientated scenario, the students gain insight into the ordering process of SAR scenes via the software EOLI-AS which is provided by the European Space Agency (ESA).
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language	In mutual agreement with the students the lectures and exercises will be presented either in English or in German

Module	**Geodetic Sensor Fusion**
Code of module:	RSGI-MPEG-7
Coordinator of module:	Heck (successor), Seitz, Westerhaus
Courses:	Geodetic Sensor Fusion
Level:	4
Credit points:	3
Contact hours:	1L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the exam.
Requirements:	—
Preconditions:	—
Recommendations:	Fundamentals of Environmental Geodesy, Part A+B
Objective:	The students discuss the strengths and weaknesses of different geodetic observation methods. They understand and evaluate strategies to derive improved products from a multi sensor fusion which is an important field of recent and future geodetic research. Students apply their knowledge and transfer it to other fields of applications. They sharpen their research interests with respect to topics to be worked upon during Lab rotations and master thesis.
Workload:	**Total workload: 90 hours** Contact hours: 21 hours - course plus course-related examination Self-study: 69 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
Content:	- Integration of physical and geometrical sensors and observations - Multi technique approaches - Theory of interpolation and collocation - Global Geodetic Observing System (GGOS) - International Terrestrial Reference Frame (mult-techniqies geodesy and geodynamics
Offered partial items of module (exams and transcripts related to lectures/labs):	—
Language:	In mutual agreement with the students the lectures and exercises will be presented either in English or in German.

Module	**Recent Earth Observation Programs and Systems**
Code of module:	RSGI-MPEG-8 (=GEOD-MWCV-7)
Coordinator of module:	Weidner
Courses:	Recent Earth Observation Programs and Systems (6043210/6043211)
Level:	4
Credit points:	2
Contact hours:	1+0
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an assessment of success of other type
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the assessment of success of other type.
Requirements:	—
Preconditions:	—
Recommendations:	Knowledge in remote sensing sensors is recommended.
Objective:	Students are aware of recent and planned Earth observation missions and able to relate the programs and sensors to each other, but also to former Earth observation programs and systems.
Workload:	**Total workload: 60 hours** **Contact hours: 15 hours** - courses plus course-related examination **Self-study: 45 hours** - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - preparations for exam
Content:	This module provides an introduction to recent and planned Earth observation programs and systems. The module addresses aspects of the sensors, but also planned and possible applications.
Offered partial items of module (exams and transcripts	—

related to lectures/labs):	

Module	**Hyperspectral Remote Sensing**
Code of module:	RSGI-MPEG-9 (=GEOD-MPEA-1)
Coordinator of module:	Weidner
Courses:	Hyperspectral Remote Sensing (6047101/6047102)
Level:	4
Credit points:	2+1
Contact hours:	1L+1E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	Successfully completed exercises as prerequisite
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	Knowledge in multispectral remote sensing is recommended.
Objective:	Students are able to explain the fundamentals of hyperspectral remote sensing, its possibilities and challenges with respect to multispectral remote sensing, including data processing specifically designed for hyperspectral data. Students are able to use their knowledge and transfer it to other fields of applications.
Workload:	**Total workload: 90 hours** Contact hours: 30 hours - courses plus course-related examination Self-study: 60 hours - consolidation of subject by recapitulation of lectures - consolidation of subject by use of references and by own inquiry - preparations for exam
Content:	This module provides an overview of hyperspectral remote sensing. It introduces students to sensor systems and concepts of data processing. A selection of approaches is presented and compared to classical approaches for the processing and classification of multispectral data. The module consists of lectures and labs.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Seminar Topics of Remote Sensing**
Code of module:	RSGI-MPEG-10 (=GEOD-MWEA-1)
Coordinator of module:	Weidner
Courses:	Seminar Topics of Remote Sensing
Level:	4
Credit points:	2
Contact hours:	1L

Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Environmental Geodesy; compulsory elective - Geoinformatics and Environmental Geodesy; compulsory elective - Remote Sensing of the Atmosphere and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (SS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	–
Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	Knowledge of fundamentals in remote sensing sensors is recommended.
Objective:	Students are able to prepare a subject on their own based on introductory lectures, given references and their own inquiry.
Workload:	**Total workload: 60 hours** Contact hours: 80 hours - introductory courses plus course-related examination - presentations Self-study: 52 hours - consolidation of subject by recapitulation of introductory lectures - consolidation and preparation of subject by use of references and by own inquiry - preparations for exam
Content:	This module gives insight in selected topics of remote sensing. Topics are close to actual research topics of interest and recent research of the Institute.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.4 Supplementary Modules

Module	**Seminar Topics of Image Analysis**
Code of module:	RSGI-MAS-2 (=GEOD-MWEB-1)
Coordinator of module:	Hinz
Courses:	Seminar Topics of Image Analysis
Level:	4
Credit points:	2
Contact hours:	1L
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics Profiles: - Computer Vision and Geoinformatics; compulsory elective - Computer Vision and Remote Sensing of the Atmosphere; compulsory elective - Computer Vision and Environmental Geodesy; compulsory elective
Duration of module:	1 semester (WS)
Exam:	The assessment consists of an oral exam (20 min.)
Particularities of exam:	–

Grade of module:	The grade of the module is the grade of the oral exam.
Requirements:	—
Preconditions:	—
Recommendations:	Knowledge of fundamentals of remote sensing sensors is recommended.
Objective:	The students learn — in the form of a seminar — selected state-of-the-art topics of image analysis. These will vary from year to year. Overall goal of this seminar is to get a insight into ways of investigating, selecting and condensing scientific work of the computer vision community, and to prepare it in such a way that the other students will benefit from it.
Workload:	**Total workload: 60 hours** Contact hours: 15 hours - introductory courses plus course-related examination - presentations Self-study: 45 hours - consolidation of subject by recapitulation of introductory lectures - consolidation and preparation of subject by use of references and by own inquiry - preparations for exam
Content:	Contents of the model include - introduction into selected topic - overview of boards, conferences, journals, books and the general structure of the image analysis and computer vision community - investigating and selecting important literature - condensing the nucleus of the respective topic - preparing hand-out and oral presentation
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.5 Lab Rotation

Two lab rotations are required. Lab rotation is practical project work, usually 6-8 weeks, in different laboratories in order to get acquainted with scientific work and to make a better qualified decision where to do the master thesis. In the optimal case the master thesis can build upon one of the lab rotations. Optionally, Lab Rotations can be done in teams.

Module	**Lab Rotation**
Code of module:	RSGI-ML
Coordinator of module:	head of Examination Commission
Courses:	
Level:	5
Credit points:	8
Contact hours:	6
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics lab rotation
Duration of module:	6-8 weeks
Exam:	other
Particularities of exam:	–
Grade of module:	the grade of the module is the grade of the exam

Requirements:	at least 45 CP shall have been acquired before a lab rotation is started.
Preconditions:	—
Recommendations:	—
Objective:	The student will get insight in lab work, will learn to work in a self-organized way. Further the student will deepen her knowledge in the topic of choice and will then be better qualified to select the topic and the research groups which fits best to her personal interest.
Workload:	Total workload: 240 hours - Literature study: 40 hours - Lab work: 140 hours - preparation of a report: 60 hours
Content:	The student works on a selected topic in one of the research groups of the involved institutes. Lab rotations at external institutions are allowable. The selection of the topic is made in agreement of the supervisor and the student. The studentfamiliarizes herself with the topic, carries out the lab work, and prepares a report.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.6 Key Competences

Module	**Language Course**
Code of module:	RSGI-MSLC
Coordinator of module:	Sprachzentrum
Courses:	Courses will be offered by the "Studienkolleg".
Level:	4
Credit points:	The minimum number of credit poins to be acquired is 2. Depending on the course chosen, more points can be acquired, which can be credited to "Supplementary Modules".
Contact hours:	depending on the course chosen.
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics; elective
Duration of module:	1 semester, WS or SS.
Exam:	depending on the course chosen.
Particularities of exam:	depending on the course chosen.
Grade of module:	depending on the course chosen.
Requirements:	—
Preconditions:	The student's abilities in German language will be tested and are relevant to the admission to a particular course.
Recommendations:	to be taken as early as possible; it is highly recommended to acquire basic knowledge in German language before.
Objective:	The students improve their abilities in German language by a measurable degree.
Workload:	depending on the course chosen.
Content:	Oral and written communication in German language, according to the level of the course chosen.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Scientific Writing**
Code of module:	RSGI-MKSR
Coordinator of module:	PEBA
Courses:	Scientific Writing
Level:	4
Credit points:	2
Contact hours:	1L+E
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics
Duration of module:	1 semester (SS)
Exam:	other
Particularities of exam:	–
Grade of module:	the grade will be the grade of a written scientific document prepared by the student.
Requirements:	—
Preconditions:	—
Recommendations:	Ideally this course is linked to a lab rotation.
Objective:	The student is able to communicate scientific content in writing. The student knows how a scientific document is to be organized, how to reference pre-existing work and how to put forward arguments in a conclusive manner.
Workload:	**Total workload: 60 hours** contact hours: 15 hours preparation of a document: 45 hours
Content:	- Types of scientific documents: journal papers, reports, books, etc. - organization of a scientific documents and the role of the various elements (abstract, introduction ...) - putting forward conclusive arguments; - referencing pre-existing work - concise wording; - authorship of a scientific document.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Module	**Further Key Competences**
Code of module:	RSGI-MK
Coordinator of module:	Studiengangsprecher
Courses: Level:	Courses are offered by - HOC: www.hoc.kit.edu/lehrangebot - ZAK: www.zak.kit.edu/sq - Sprachzentrum: www.spz.kit.edu 4
Credit points:	all in all 6 CP are required in key competences
Contact hours:	depending on the course
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics
Duration of module:	depending on the course, WS/SS
Exam:	other
Particularities of exam:	depending on the course
Grade of module:	not graded
Requirements:	depending on the course

Preconditions:	—
Recommendations:	—
Objective:	Developing cross-cutting competences Detailed information is available from the involved institutions.
Workload:	Total workload of all courses in key competences: 180 hours. Details depend on the selected courses
Content:	See information provided by the involved institutions (internet addresses are listed above.)
Offered partial items of module (exams and transcripts related to lectures/labs):	—

5.7 Master Thesis

Module	**Master Thesis**
Code of module:	RSGI-M
Coordinator of module:	Head of Examination Commission
Courses:	
Level:	5
Credit points:	30 CP
Contact hours:	
Degree program and topic:	M. Sc. Remote Sensing and Geoinformatics master thesis
Duration of module:	6 months
Exam:	thesis and assessment of success of other type
Particularities of exam:	after the submission of the thesis the student has to present and defend the key results of the thesis in a seminar.
Grade of module:	The thesis will be evaluated by the supervisor and another examiner of the faculty. One of these must be professor or junior professor. In the case of disagreeing grades the arithmetic mean is calculated.
Requirements:	At least 70 CP shall have been acquired before the master thesis is started.
Preconditions:	—
Recommendations:	—
Objective:	Learning outcomes: - Application of the subject-specific knowledge and methods learned during the studies. - self-organized conception and independent execution of a scientific project. - interpretation and communication of the obtained results in written form.
Workload:	**Total workload: 6 months**
Content:	Execution of a scientific project under supervision.
Offered partial items of module (exams and transcripts related to lectures/labs):	—

Chapter 6

Exemplary Schedules

To demonstrate the self-consistence of the master course, exemplary valid course selections are outlined below. The earliest possible dates of examinations are mentioned. Cumulation of possible dates in early semesters does not entail any particularly extensive examination-related workload in these semesters, because examinations can be shifted into the next semester. Examinations are mentioned after the last course of the relevant module. They include, however, also the content of the other courses of the module. Early possibility of examinations just increases the flexibility. Some courses have fractional credit points but the modules always have full credit points.

6.1 Exemplary Course: Profile Computer Vision and Geoinformatics

1st Semester

Compulsory

- Numerical Mathematics (6 CP) **Examination**
- Scientific Programming (3 CP) **Examination**
- Methods of Remote Sensing (3 CP)
- Image Processing and Computer Vision (3 CP) **Examination**
- Geoinformatics Part A (2.5 CP)
- Introduction to Atmospheric Remote Sensing Part 1 (3 CP)
- Fundamentals of Environmental Geodesy Part A (2.5 CP)
- Advanced Topics in Computer Vision (5 CP) **Examination**
- GeoDB (5 CP) **Examination**

Compulsory Elective:

- none

Elective:

- none

33 CP; 5 examinations

2nd Semester

Compulsory:

- Basics of Estimation Theory and its Application in Geoscience Remote Sensing (6 CP) **Examination**
- Sensors and Signals in Computer Vision and Remote Sensing (2 CP)

- Geoinformatics Part B (2.5 CP) **Examination**
- Introduction to Atmospheric Remote Sensing Part 2 (2 CP) **Examination**
- Fundamentals of Environmental Geodesy Part B (2.5 CP) **Examination**

Compulsory Elective:

- Active Sensors for Computer Vision (3 CP) **Examination**
- Tomographic Laser and Radar Sensing (3 CP) **Examination**
- 3D/4D GIS (4 CP) **Examination**

Elective:

- Seminar Topics of Remote Sensing (2 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**

29 CP; 9 examinations

3rd Semester

Compulsory:

- Lab Rotation 1 (10 CP) **Study Achievement**
- Lab Rotation 2 (10 CP) **Study Achievement**

Compulsory Elective:

-

Elective:

- Remote Sensing od Aerosols and Clouds (3 CP) **Examination**
- Geodetic Sensor Fusion (3 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**

28 CP; 3 examinations

4th Semester Master Thesis (30 CP)

6.2 Exemplary course: Profile Computer Vision and Remote Sensing of the Atmosphere

1st Semester

Compulsory

- Numerical Mathematics (6 CP) **Examination**
- Scientific Programming (3 CP) **Examination**
- Methods of Remote Sensing (3 CP)
- Image Processing and Computer Vision (3 CP) **Examination**
- Geoinformatics Part A (2.5 CP)
- Introduction to Atmospheric Remote Sensing Part 1 (3 CP)
- Fundamentals of Environmental Geodesy Part A (2.5 CP)
- Advanced Topics in Computer Vision (5 CP) **Examination**
- Passive Remote Sensing of Atmospheric Temperature and Composition (2 CP)

Compulsory Elective:

- none

Elective:

- Atmospheric Radiation (2 CP) **Examination**

32 CP; 5 examinations

2nd Semester

Compulsory:

- Basics of Estimation Theory and its Application in Geoscience Remote Sensing (6 CP) **Examination**
- Sensors and Signals in Computer Vision and Remote Sensing (2 CP)
- Geoinformatics Part B (2.5 CP) **Examination**
- Introduction to Atmospheric Remote Sensing Part 2 (2 CP) **Examination**
- Fundamentals of Environmental Geodesy Part B (2.5 CP) **Examination**
- Remote Sensing of Aerosols and Clouds (3 CP) **Examination**

Compulsory Elective:

- Active Sensors for Computer Vision (3 CP) **Examination**
- Tomographic Laser and Radar Sensing (3 CP) **Examination**
- Atmospheric Spectroscopic Measurements (2 CP)
- The Middle Atmosphere: Processes and Research Methods (2 CP) **Examination**

Elective:

- Recent Earth Observation Programs and Systems (2 CP) **Examination**

30 CP; 9 examinations

3rd Semester

Compulsory:

- Lab Rotation 1 (10 CP) **Study Achievement**
- Lab Rotation 2 (10 CP) **Study Achievement**

Compulsory Elective:

- none

Elective:

- Augmented Reality (4 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**

28 CP; 3 examinations

4th Semester Master Thesis (30 CP)

6.3 Exemplary course: Profile Computer Vision and Environmental Geodesy

1st Semester

Compulsory

- Numerical Mathematics (6 CP) **Examination**
- Scientific Programming (3 CP) **Examination**
- Methods of Remote Sensing (3 CP)
- Image Processing and Computer Vision (3 CP) **Examination**
- Geoinformatics Part A (2.5 CP)
- Introduction to Atmospheric Remote Sensing Part 1 (3 CP)

- Fundamentals of Environmental Geodesy Part A (2.5 CP)
- Advanced Topics in Computer Vision (5 CP) **Examination**
- Mass Variations (2 CP)
- Seminar Earth Observation (1 CP)

Compulsory Elective:

- Seminar Topics of Image Analysis (2 CP) **Examination**

Elective:

- none

33 CP; 5 examinations

2nd Semester

Compulsory:

- Basics of Estimation Theory and its Application in Geoscience Remote Sensing (6 CP) **Examination**
- Sensors and Signals in Computer Vision and Remote Sensing (2 CP)
- Geoinformatics Part B (2.5 CP) **Examination**
- Introduction to Atmospheric Remote Sensing Part 2 (2 CP) **Examination**
- Fundamentals of Environmental Geodesy Part B (2.5 CP) **Examination**
- Deformation Processes (2 CP) **Examination**

Compulsory Elective:

- Active Sensors for Computer Vision (3 CP) **Examination**
- SAR and InSAR Remote Sensing (3 CP) **Examination**
- Seminar Topics of Remote Sensing (2 CP) **Examination**

Elective:

- Atmospheric Spectroscopic Measurements (2 CP)
- The Middle Atmosphere: Processes and Research Methods (2 CP) **Examination**

29 CP; 9 examinations

3rd Semester

Compulsory:

- Lab Rotation 1 (10 CP) **Study Achievement**
- Lab Rotation 2 (10 CP) **Study Achievement**

Compulsory Elective:

-

Elective:

- Atmospheric Radiation (2 CP) **Examination**
- Seminar Topics of Remote Sensing (2 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**

28 CP; 4 examinations

4th Semester Master Thesis (30 CP)

6.4 Exemplary course: Profile Geoinformatics and Remote Sensing of the Atmosphere

1st Semester

Compulsory

- Numerical Mathematics (6 CP) **Examination**
- Scientific Programming (3 CP) **Examination**
- Methods of Remote Sensing (3 CP)
- Image Processing and Computer Vision (3 CP) **Examination**
- Geoinformatics Part A (2.5 CP)
- Introduction to Atmospheric Remote Sensing Part 1 (3 CP)
- Fundamentals of Environmental Geodesy Part A (2.5 CP)
- GeoDB (5 CP) **Examination**
- Passive Remote Sensing of Atmospheric Temperature and Composition (2 CP)

Compulsory Elective:

- Atmospheric Radiation (2 CP) **Examination**

Elective:

- none

32 CP 5 examinations

2nd Semester

Compulsory:

- Basics of Estimation Theory and its Application in Geoscience Remote Sensing (6 CP) **Examination**
- Sensors and Signals in Computer Vision and Remote Sensing (2 CP)
- Geoinformatics Part B (2.5 CP) **Examination**
- Introduction to Atmospheric Remote Sensing Part 2 (2 CP) **Examination**
- Fundamentals of Environmental Geodesy Part B (2.5 CP) **Examination**
- Remote Sensing of Aerosols and Clouds (3 CP) **Examination**

Compulsory Elective:

- 3D/4D GIS (4 CP) **Examination**
- Atmospheric Spectroscopic Measurements (2 CP)
- The Middle Atmosphere: Processes and Research Methods (2 CP) **Examination**

Elective:

- Recent Earth Observation Systems and Programs (2 CP) **Examination**
- Seminar Topics of Remote Sensing (2 CP) **Examination**

30 CP; 9 examinations

3rd Semester

Compulsory:

- Lab Rotation 1 (10 CP) **Study Achievement**
- Lab Rotation 2 (10 CP) **Study Achievement**

Compulsory Elective:

- none

Elective:

- Augmented Reality (4 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**

28 CP; 3 examinations

4th Semester Master Thesis (30 CP)

6.5 Exemplary course: Profile Geoinformatics and Environmental Geodesy

1st Semester

Compulsory

- Numerical Mathematics (6 CP) **Examination**
- Scientific Programming (3 CP) **Examination**
- Methods of Remote Sensing (3 CP)
- Image Processing and Computer Vision (3 CP) **Examination**
- Geoinformatics Part A (2.5 CP)
- Introduction to Atmospheric Remote Sensing Part 1 (3 CP)
- Fundamentals of Environmental Geodesy Part A (2.5 CP)
- GeoDB (5 CP) **Examination**
- Mass Variations (2 CP)
- Seminar Earth Observation (1 CP)

Compulsory Elective:

- none

Elective:

- none

31 CP; 4 examinations

2nd Semester

Compulsory:

- Basics of Estimation Theory and its Application in Geoscience Remote Sensing (6 CP) **Examination**
- Sensors and Signals in Computer Vision and Remote Sensing (2 CP)
- Geoinformatics Part B (2.5 CP) **Examination**
- Introduction to Atmospheric Remote Sensing Part 2 (2 CP) **Examination**
- Fundamentals of Environmental Geodesy Part B (2.5 CP) **Examination**
- Deformation Processes (2 CP) **Examination**

Compulsory Elective:

- 3D/4D GIS (4 CP) **Examination**
- SAR and InSAR Remote Sensing (3 CP) **Examination**
- Hyperspectral Remote Sensing (3 CP) **Examination**

Elective:

- Atmospheric Spectroscopic Measurements (2 CP)
- The Middle Atmosphere: Processes and Research Methods (2 CP) **Examination**

31 CP; 9 examinations

3rd Semester

Compulsory:

- Lab Rotation 1 (10 CP) **Study Achievement**
- Lab Rotation 2 (10 CP) **Study Achievement**

Compulsory Elective:

- none

Elective:

- Augmented Reality (4 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**

28 CP; 3 examinations

4th Semester Master Thesis (30 CP)

6.6 Exemplary course: Profile Remote Sensing of the Atmosphere and Environmental Geodesy

1st Semester

Compulsory

- Numerical Mathematics (6 CP) **Examination**
- Scientific Programming (3 CP) **Examination**
- Methods of Remote Sensing (3 CP)
- Image Processing and Computer Vision (3 CP) **Examination**
- Geoinformatics Part A (2.5 CP)
- Introduction to Atmospheric Remote Sensing Part 1 (3 CP)
- Fundamentals of Environmental Geodesy Part A (2.5 CP)
- Passive Remote Sensing of Atmospheric Temperature and Composition (2 CP)
- Mass Variations (2 CP)
- Seminar Earth Observation (1 CP)

Compulsory Elective:

- none

Elective:

- Augmented Reality (4 CP) **Examination**

32 CP; 4 examinations

2nd Semester

Compulsory:

- Basics of Estimation Theory and its Application in Geoscience Remote Sensing (6 CP) **Examination**
- Sensors and Signals in Computer Vision and Remote Sensing (2 CP)
- Geoinformatics Part B (2.5 CP) **Examination**
- Introduction to Atmospheric Remote Sensing Part 2 (2 CP) **Examination**
- Fundamentals of Environmental Geodesy Part B (2.5 CP) **Examination**
- Remote Sensing of Aerosols and Clouds (3 CP) **Examination**
- Deformation Processes (2 CP) **Examination**

Compulsory Elective:

- Atmospheric Spectroscopic Measurements (2 CP)
- The Middle Atmosphere: Processes and Research Methods (2 CP) **Examination**
- Global Gravity Field Modeling (3 CP) **Examination**
- SAR and InSAR Remote Sensing (3 CP) **Examination**

Elective:

- none

30 CP; 9 examinations

3rd Semester

Compulsory:

- Lab Rotation 1 (10 CP) **Study Achievement**
- Lab Rotation 2 (10 CP) **Study Achievement**

Compulsory Elective:

- none

Elective:

- 3D/4D GIS (4CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**
- Course of Choice in Key Competences (2 CP) **Examination**

28 CP; 3 Examinations

4th Semester Master Thesis (30 CP)