Appendix 2 to the departmental study regulations for the

Master of Geomatics

Module descriptions

Contents

Compulsory elective modules in the general discipline

GEO.21.002	**Management in Business and Authorities**		
Module title (German)	Management in Unternehmen und Behörden		
Responsibilities	Professor of metrology and informatics		
Credits	6		
Courses	LGM	Master Landscape Studies and Greenspace Management Compulsory elective module in semester 2 (conversion)	2020
	GEO	Master of Geomatics Compulsory elective module in the general discipline in semester 2	2021
Recurrence frequency and duration	Start of every winter semester over one semester		
Prerequisite	None		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	SCH120 Written examination of 120 minutes
Assessment prerequisite	None

Classes and workload

I	GEO.21.002.1	Management in Business and Authorities Lecture, 2 CH	32 h
II	GEO.21.002.2	Management in Business and Authorities Tutorial, 2 CH	32 h
IIII		Independent project work	20 h
IV		Autonomous preparation/follow-up incl. exam preparation	96 h
		Total:	180 h

Teaching staff	Professor of metrology and informatics
Teaching language	English
Contents	The classes cover: - Activity of businesses and authorities in society - Regulatory environment - Range of services - Service provision - Product life cycle management - Mission, vision, strategy, tactics - Operational business, controlling - Quality management, risk management - Certification, validation, verification, accreditation - Liability issues, data privacy - Personnel management, international management

	- Planned responses to severe disruptions
Learning objectives / outcomes	The students will obtain the foundational knowledge and skills required for subsequently taking on managerial responsibility. They will be confronted with the typical complexity of decisions in business or authorities. Carrying out independent project work will promote personal initiative and teamwork. Instead of teaching preprepared standard solutions, the students will instead participate in the research and development of modern management methods. After completing the module, the students will be able to: - Develop options for strategic and operative decisions regarding company and regulatory policy - Critically assess risks and suggest mitigation procedures - Exploit scope for action even with severe disruptions and incomplete information
Teaching and learning formats	Lecture on whiteboard and projector to present the contents Exercises using concrete examples for practical completion Guided self-study for preparation and follow-up Development and presentation of the student's own project
Literature	Directives of the European Union, according to subject ISO 9001, various Certification Standards, current edition General Data Protection Regulation EU, current version ISO 31000, current version Additional literature will be announced in the lecture (current research articles, etc.)
Further information	-

GEO.21.045 IT Security

Module title (German)	IT-Sicherheit		
Responsibilities	Professor of metrology and informatics		
Credits	6		
Courses	GEO	Geomatics Compulsory elective module in the general discipline in semester 1	2021
	LGM	Landscape Studies and Greenspace Management Compulsory elective module in semester 2	2020
Recurrence frequency and duration	Starts every summer semester over one semester		
Prerequisite	None		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	SCH120 Written examination of 120 minutes' duration or AHA15 Assignment of approx. 15 pages The type of assessment is announced at the start of the particular semester by the examiner.
Assessment prerequisite	Successful completion of the exercises

Classes and workload

I	GEO.21.045.1	IT Security Lecture, 2 CH	32 h
II	GEO.21.045.2	IT Security Tutorial, 2 CH	32 h
III		Autonomous preparation and follow-up incl. exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of metrology and informatics, Professor of applied and practical informatics
Teaching language	English
Contents	The classes cover: - Mathematical principles - Cryptosystems and cryptoprotocols - Encryption methods - Technological aspects - Security objectives and threats - Integrity and availability - Authentication and authorisation - Network and industrial IT protection - Enterprise IT security - Regulatory frameworks and audits - Mobile device management, ISMS

	- Responses to threat scenarios
Learning objectives / outcomes	After completing the module, students will be able to: - Recognise basic threats in regard to IT security and evaluate their essential features - Evaluate basic procedures to ensure IT security in regard to their applicability and effectiveness - Define security objectives for data security and data safety and analyse operational IT situations in terms of existing risks - Describe the element of human factors in IT security and instructively influence employees' preventive behaviour in the workplace
Teaching/learning formats*	Lecture on whiteboard, projector and in computer lab to present the contents Tutorials, in some cases laboratory exercises for device configuration/ programming using concrete examples from industry and authorities for practical completion Self-study for preparation and follow-up
Literature*	Announced in the first lecture
Further information*	[…]

GEO.21.049 German Language

Module title (German)	Deutsch für Studierende
Responsibilities	Language Centre
Credits	6
Courses	GEO Geomatics 2021 Compulsory elective module in semester 1
Recurrence frequency and duration	Starts every summer semester over one semester
Prerequisite	None

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AHA15 Assignment of approx. 15 pages or AP20 Presentation of approx. 20 minutes' duration or AP10 Report of approx. 10 minutes' duration with written paper of approx. 10 pages The examiner will announce the type of assessment at the start of the semester.
Assessment prerequisite	None

Classes and workload

I	SPZ.21.0??.1	German Language Tuition in seminars, 4 CH	64 h
II		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Language Centre
Teaching language	German
Contents	German. Expansion of language skills to level B1: Learning to communicate from B1 onward Consolidation of linguistic competence and consideration of quality of expression
Learning objectives / outcomes	Acquisition of additional knowledge of the foreign language, consolidation and expansion of linguistic and cultural knowledge, specialist language skills. From B1 level: Acquisition of the ability to move at an international level.
Teaching and learning formats	Didactic aids will be organised in many cases by the students based on experience: Projection of audio and visual documents (projector), audio texts using qualitative technical facilities. The Moodle learning platform will be used intensively in all languages.
Literature	Text books based on level, issues from journals, audio documents from the internet, BBC Mundo.
Further information	Additional literature available in German and English.

Compulsory elective modules in the Geodesy discipline

GEO.21.006 Physical Geodesy

Module title (German)	Physikalische Geodäsie
Responsibilities	Prof. of practical geodesy, geodetic computations, land surveying, satellite geodesy
Credits	6
Courses	GEO Master of Geodesy and Geoinformatics 2021 Compulsory elective module in semester 1
Recurrence frequency and duration	Start of every summer semester over one semester
Prerequisite	Foundational knowledge of coordinate systems, position, altitude, height, gravity, GNSS recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration or SCH120 Written examination of 120 minutes The examiner will announce the type of assessment at the start of the semester.
Assessment prerequisite	Evidence of attendance at seminars and accepted seminar assignments. Examination by the lecturers. More detailed provisions are contained in section 4 of the departmental examination regulations.

Classes and workload

I	GEO.21.006.1	Physical Geodesy Lecture, 2 CH	32 h
II	GEO.21.006.2	Physical Geodesy Seminar, 2 CH	32 h
IIII		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Prof. of practical geodesy, geodetic computations, land surveying, satellite geodesy Prof. of mathematics, geometry, applied informatics
Teaching language	German
Contents	The classes cover: - Principles of potential theory - Earth's gravity field - Gravity reductions - Heights - Geometry of the Earth

	- Gravity field outside the Earth - Satellite methods
Learning objectives / outcomes	After successfully completing the module, the students will have acquired fundamental knowledge of physical geodesy and geodetic modelling. They will know how to describe the Earth's gravity field, explain gravity reductions and distinguish various height systems. They will be familiar with various satellite missions that can be used to obtain information about the Earth's gravity field.
Teaching and learning formats	Lecture on whiteboard and projector to present the contents Guided self-study for preparation and follow-up Development and presentation of selected subjects
Literature	Hofmann-Wellenhof, Moritz: Physical Geodesy, Springer, 2005 Additional literature will be announced in the lecture (current research articles, etc.)
Further information	-

GEO.21.009 Real Estate Registry

Module title (German)	Liegenschaftskataster
Responsibilities	Prof. of evaluation, real estate registry, planning
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective modules in the Geodesy discipline in semester 2
Recurrence frequency and duration	Start of every winter semester over one semester
Prerequisite	Foundational knowledge of the real estate registry recommended

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Successful submission of papers. Examination by the lecturers.

Classes and workload

I	GEO.21.009.1	Real Estate Registry Lecture, 2 CH	32 h
II	GEO.21.009.2	Real Estate Registry L Seminar, 2 CH	32 h
III		Autonomous preparation and follow-up including exam preparation and papers	116 h
		Total:	180 h

Teaching staff	Prof. of evaluation, real estate registry, planning
Teaching language	German
Contents	The classes cover: - Boundary definitions and demarcation procedures (term boundary, procedures for defining land parcel boundaries, demarcation procedures) - Handling objections, - Handling legally valid boundary changes
Learning objectives / outcomes	After successfully completing the module, the students will be able to carry out boundary definition and demarcation procedures. They will be able to process objections and implement legally valid boundary changes.
Teaching and learning formats	Lecture on whiteboard and projector to present the module contents. Tutorials and seminars on the subjects dealt with in the lecture. The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.
Literature	Kriegel, Herzfeld: Katasterkunde in Einzeldarstellungen, loose-leaf binder Bengel, Simmerding (2000): Grundbuch, Grundstück, Grenze Kummer, Möllering (20059. Kommentar zum Vermessungs- und Geoinformationsrecht Sachsen-Anhalt Gomille (2008): Kommentar zum Niedersächsischen Vermessungsgesetz Kummer/Frankenberg (2010): Das Deutsche Vermessungs- und Geoinformationswesen Current literature on the issues being discussed in each case.

Further information	-

GEO.21.015 Engineering Geodesy

Module title (German)	Ingenieurgeodäsie		
Responsibilities	Professor of practical geodesy and engineering surveying		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory elective module in the Geodesy discipline in semester 2	2021
Recurrence frequency and duration	Start of every winter semester over one semester		
Prerequisite	Knowledge equivalent to a Bachelor of Geodesy is required.		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Accepted paper on the student's own project. Examination by the lecturers.

Classes and workload

I	GEO.21.015.1	Engineering Geodesy Lecture, 2 CH	28 h
II	GEO.21.015.2	Engineering Geodesy Tutorial, 2 CH	28 h
IIII		Independent project work	20 h
IV		Autonomous preparation and follow-up including exam preparation	104 h
		Total:	180 h

Teaching staff	Professor of practical geodesy and engineering surveying
Teaching language	English
Contents	The classes cover: - Introduction to inertial technology - Consolidation in the area of the single-axis inertial sensors (inclinometer, accelerometer and north finder) with special reference to north-finder systems - Data collection, manual and digital. In-situ calibration and error monitoring - Strategy for underground and tunnel measurement - Various designs of surveying gyroscopes with possible errors and application - Automatic data collection while monitoring. Filter techniques and data processing.
Learning objectives / outcomes	After completing the module, the students will be able to: - Master the use of modern surveying methods and systems in engineering geodesy, specifically inertial technology and gyroscopes - Describe manual and automatic systems to record deformations - Process measurement data that is generated (data collection and filtration) - Use low-cost sensors (MEMS)

	- Master the application and assessment of specific procedures for micro-tunnelling and tunnel construction
Teaching and learning formats	Lecture on whiteboard and projector to present the contents Exercises using concrete examples for practical completion Guided self-study for preparation and follow-up Completion and presentation of the student's own project and an underground measurement
Literature	Jekeli, Christopher; Inertial Navigation Systems with Geodetic Applications: De Gruyter, 1st ed. 2000; ISBN-10: 3110159031 (English) Von Fabeck, Wolf; Kreiselgeräte, Vogel-Verlag; 1 ed. 1980; ISBN-3-8023-0612-0 Gyro-principles, Gyro-basics, Gyro-training, Presentations from the Gyro-Symposium Joburg 2010. DVW conference proceedings: Geomonitoring
Further information	-

GEO.21.016 Special Methods of Adjustment and Statistics

Module title (German)	Ausgewählte Methoden der Ausgleichungsrechnung und Statistik
Responsibilities	Professor of adjustment theory, statistics and practical geodesy
Credits	6

Courses	GEO	Master of Geomatics Compulsory elective module in the Geodesy discipline in semester 1	2021
Recurrence frequency and duration	Starts every summer semester over one semester		
Prerequisite	I	Mathematics at higher education entrance level is recommended.	
	II	Successful completion of Error theory and statistics GMT.077.	
	III	Successful completion of Adjustment theory GMT.019.	

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	SCH120 Written examination of 120 minutes' duration or M30 Oral examination of approx. 30 minutes' duration or AHA50 Assignment of approx. 50 pages The type of assessment will be defined at the start of the module and announced by the examiner.
Assessment prerequisite	Successful completion of the tutorials. Examination by the lecturers.

Classes and workload

I	GEO.21.016.1	Special Methods of Adjustment and Statistics Lecture, 2 CH	32 h
II	GEO.21.016.2	Special Methods of Adjustment and Statistics Tutorial, 2 CH	32 h
III		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of adjustment theory, statistics and practical geodesy
Teaching language	German
Contents	The classes cover: - Functional modelling using constraint equations - Stochastic modelling - Adjustment algorithms of constrained observations as well as the universal model (Gauß-Helmert model) - Regression models - Collocation - KALMAN filters - Selected test methods

Learning objectives / outcomes	After completing the module, the students will be able to: - Master the use of adjustment approaches using constraint equations for adjusting constrained observations as well as the universal model for adjustment theory (Gauß-Helmert model) - Handle selected statistical methods (regression models, collocation, KALMAN filtering, specific test methods)
Teaching/learning formats*	Lecture on whiteboard or with tablet, projector, computer. Computational exercises with free and commercial software. Self-study for preparation and follow-up
Literature*	- Foppe (2010): Repetitorium zur Fehlerlehre und Statistik und Ausgleichungsrechnung - Pelzer (1985): Geodätische Netze in der Landes- und Ingenieurvermessung - Niemeier (2011): Ausgleichungsrechnung Additional literature will be announced in the lecture.
Further information*	[…]

GEO.21.031 Metrology

Module title (German)	Messtechnik
Responsibilities	Professor of metrology and informatics
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the Geodesy discipline in semester 1
Recurrence frequency and duration	Start of every summer semester over one semester
Prerequisite	None

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Accepted paper on the student's own project. Examination by the lecturers.

Classes and workload

I	GEO.21.031.1	Metrology Lecture, 2 CH	32 h
II	GEO.21.031.2	Metrology Tutorial, 2 CH	32 h
IIII		Independent project work	20 h
IV		Autonomous preparation and follow-up including exam preparation	96 h
		Total:	180 h

Teaching staff	Professor of metrology and informatics
Teaching language	English
Contents	The classes cover: - Definitions as per ISO, EN, DIN - Regulatory aspects of metrology - Data collection: Sensors, signal processing, scanning, quantisation and discretisation errors, transfer function, measurement uncertainty - Data transmission: Sensor interfaces, analogue and digital transmission, speed vs distance vs data integrity, serial vs parallel transmission, signal processing, UART, I2C, SPI, one wire, CAN, field buses, TCP/UDP, IP, ADFX, bus capability, networks and protocols, collision and traffic control, multiplexing, error detection and data recovery, safety and security aspects - Data evaluation: Alerting, process controls, logging, monitoring, human-machine interfaces, archiving
Learning objectives / outcomes	After completing the module, the students will be able to: - Express the knowledge and skills needed for determining complex measurement tasks and their framework conditions with regard to subsequent assumption of managerial responsibilities in the engineering sector - Be aware of the challenges associated with globalised or multinational metrology projects and be familiar with in-house/international metrological standardisation initiatives for their solution

	- Deal with the typical complexities of pro and contra, including of a financial nature, that are associated with the various options for data collection, transmission and evaluation - Develop initiative and teamwork skills through comprehensive group project work - Develop proposals to solve complex metrology tasks in the context of businesses or authorities - Estimate enterprise and regulatory risks in regard to measurement processes and propose mitigating measures - Limit major causes of metrological failures and develop strategies to recover the ability to perform metrological processes
Teaching and learning formats	Lecture on whiteboard, projector and in metrology lab to present the contents Consulting on the websites of calibration laboratories, national and international organisations with metrological functions. Exercises (computations/programming) using concrete examples for practical completion Guided self-study for preparation and follow-up Completion and presentation of the student's own project
Literature	International and in-house metrological standards, each in the current version, data sheets, white papers with metrological reference Additional literature will be announced in the lecture
Further information	-

GEO.21.032 Land Readjustment

Module title (German)	Bodenordnung		
Responsibilities	Professor of evaluation, real estate registry and planning		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory elective module in the Geodesy discipline in semester 2	2021
Recurrence frequency and duration	Start of every winter semester over one semester		
Prerequisite	Knowledge of land and planning law is recommended.		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Accepted seminar presentations. Examination by the lecturers.

Classes and workload

I	GEO.21.032.1	Land Readjustment Lecture, 2 CH	32 h
II	GEO.21.032.2	Land Readjustment Seminar, 2 CH	32 h
III		Autonomous preparation and follow-up including exam preparation and seminar presentations	116 h
		Total:	180 h

Teaching staff	Prof. Rolf-Werner Rebenstorf
Teaching language	German
Contents	The classes cover: - International planning and land law in selected EU countries - Discussion of proposed reforms
Learning objectives / outcomes	After successfully completing the module, the students will be familiar with the functioning of urban land markets in selected EU member states. They will be familiar with the points of reference of the current discussion: Sustainability, suburbanisation, land usage, land tax reform.
Teaching and learning formats	Lecture on whiteboard and projector to present the module contents. Tutorials and seminars on the subjects dealt with in the lecture. The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.
Literature	BMBau (1993): Funktionsweise städtischer Bodenmärkte in Mitgliedsstaaten der EG. Bonn BBR (2001): Baulandbereitstellung nach dem niederländischen Modell. Bonn. Uni Kassel (2003): Europäisches Planungsrecht.
Further information	Current documentation for each of the programs used. -

GEO.21.046 Unmanned Aerial Vehicles

Module title (English)	Unbemannte Fluggeräte
Responsibilities	Professor of metrology and informatics
Credits	6

Courses	GEO	Master of Geomatics Compulsory elective module in the Geodesy discipline in semester 1	2021

Recurrence frequency and duration	Starts every summer semester over one semester
Prerequisite	None

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	SCH120 Written examination of 120 minutes' duration
Assessment prerequisite	Successful completion of the tutorials and the project. Examination by the lecturers.

Classes and workload

I	GEO.20.046.1	Unmanned Aerial Vehicles Lecture, 2 CH	32 h
II	GEO.21.046.2	Unmanned Aerial Vehicles Tutorial, 1 CH	16 h
III		Independent project work	22 h
IV		Autonomous preparation and follow-up including exam preparation	110 h
		Total:	180 h

Teaching staff	Professor of metrology and informatics, among others
Teaching language	English
Contents	The classes cover: - Aviation law - Aerodynamics - Flight mechanics - Electrical systems and sensors - Remote control - Photogrammetry - Navigation - Reliability evaluation of unmanned aerial vehicles (UAV) - Major project
Learning objectives / outcomes	After completing the module, the students will be able to - Assess the opportunities for and limits of drone usage - Comply with the regulatory rules for participating in air traffic - Promptly identify hazards associated with drone usage and initiate mitigation measures

	- Plan, execute and evaluate typical tasks for UAV-supported 3D data generation
Teaching/learning formats*	Lecture on whiteboard and projector to present the contents Exercises using concrete examples for practical completion. Major practical project for 3D recording of geometric data on buildings and landscape objects.
Literature*	
Further information*	[…]

GEO.21.047 Advanced Surveying 1

Module title (German)	Fortgeschrittene Aspekte der Ingenieurvermessung 1
Responsibilities	Professor of practical geodesy and engineering surveying
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the Geodesy discipline in semester 1
Recurrence frequency and duration	Start of every summer semester over one semester
Prerequisite	Foundational knowledge of GNSS, terrestrial laser scanning, engineering surveying is recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Evidence of attendance at seminars and accepted seminar project report with presentation. Examination by the lecturers. More detailed provisions are contained in section 4 of the departmental examination regulations.

Classes and workload

I	GEO.21.047.1	Advanced Surveying 1 Lecture, 2 CH	32 h
II	GEO.21.047.2	Advanced Surveying 1 Seminar, 2 CH	32 h
IIII		Autonomous preparation and follow-up including exam preparation and project realisation	116 h
		Total:	180 h

Teaching staff	Professor of practical geodesy and engineering surveying
Teaching language	English
Contents	- Principles of inertial sensors (INS) regarding dynamic application for mobile mapping systems, including MEMS INS. - Special focus: Possible errors, ZUPT/CUPT and calibration - Mobile mapping systems: Concept and function. - Practical component: Realisation of a multi-sensor system based on INS and TLS.
Learning objectives / outcomes	- The students can critically assess the use of the latest multi-sensors based on inertial sensors and TLS. - Students can evaluate these systems compared to conventional geodetic sensors to ensure economical use. - The increased error budget due to the inertial sensors and consideration of sensor fusion is known. - The students can also assess the use of these systems for more complex measurement tasks.

Teaching and learning formats	Lecture on whiteboard and projector to present the contents Guided self-study for preparation and follow-up Completion of a project with specified questions. Work in the laboratory Programming activities
Literature	Jan Wendel, Integrierte Navigation, 2011 MEMS-Based integrated Navigation, Priyanka Aggarwal et. al., 2010 Additional literature will be announced in the lecture (current research articles and conference proceedings) Precise indoor mapping as a basis for coarse indoor navigation, H Sternberg, F Keller, T Willemsen, Journal of applied geodesy 7 (4), 231-246, 2013 Mobile data capturing on roads and railways utilizing the kinematic survey system KiSS, H Sternberg, W Caspary, H Heister, J Klemm, Proceedings of the 3rd International Symposium on Mobile Mapping Technology, 2001 Multi-sensor platform for indoor mobile mapping: System calibration and using a total station for indoor applications, F Keller, H Sternberg, Remote sensing 5 (11), 5805-5824, 2013
Further information	-

GEO.21.048 Advanced Surveying 2

Module title (German)	Fortgeschrittene Aspekte der Ingenieurvermessung 2
Responsibilities	Professor of practical geodesy and engineering surveying
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the Geodesy discipline in semester 2
Recurrence frequency and duration	Start of every winter semester over one semester
Prerequisite	Foundational knowledge of geodetic metrology: total stations, laser scanners, GNSS is recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Evidence of attendance at seminars and accepted seminar project report with presentation. Examination by the lecturers. More detailed provisions are contained in section 4 of the departmental examination regulations.

Classes and workload

I	GEO.21.048.1	Advanced Surveying 2 Lecture, 2 CH	32 h
II	GEO.21.048.2	Advanced Surveying 2 Seminar 2 CH	32 h
III		Autonomous preparation and follow-up including exam preparation and project completion	116 h
		Total:	180 h

Teaching staff	Professor of practical geodesy and engineering surveying
Teaching language	English
Contents	The classes cover: - Principles of modern multi-sensor systems - Influence of time on multi-sensor systems - Calibration (lever arm) between the sensor coordination systems - Use of a Monte Carlo simulation for precision estimation of multi-sensor systems - Measurement exercises to determine time offset, triggering of sensors as well as lever arm determination of the HS multi-sensor system
Learning objectives / outcomes	After completing the module, the students will be able to: - Estimate the influencing factor time for dynamically operating multi-sensor systems - Plan and evaluate the processing of major measurement tasks with multi-sensor systems

- Evaluate complex dynamic processes in regard to their accuracy; the measurement system or the object can be a mobile component here. For this purpose, students can use the Monte Carlo simulation.

Teaching and learning formats	Lecture on whiteboard and projector to present the contents Guided self-study for preparation and follow-up Completion of a project with specified questions. Work in the laboratory Programming activities
Literature	Theses of Dr Christian Hesse (Eng.): *Ein Beitrag zur hochauflösenden kinematischen Objekterfassung mit terrestrischen Laserscannern*, by Dr Friedrich Keller (Eng.): *Entwicklung eines forschungsorientierten Multi-Sensor-Systems zum kinematischen Laserscanning innerhalb von Gebäuden* and Prof. Harald Sternberg (Eng.): *Zur Bestimmung der Trajektorie von Landfahrzeugen mit einem hybriden Meßsystem* MEMS-Based integrated Navigation, Priyanka Aggarwal et. al., 2010 Sequential Monte Carlo Methods in Practice, Arnaud Doucet et. al., 2010 Precise indoor mapping as a basis for coarse indoor navigation, H Sternberg, F Keller, T Willemsen, Journal of applied geodesy 7 (4), 231-246, 2013 Mobile data capturing on roads and railways utilizing the kinematic survey system KiSS, H Sternberg, W Caspary, H Heister, J Klemm, Proceedings of the 3rd International Symposium on Mobile Mapping Technology, 2001 Multi-sensor platform for indoor mobile mapping: System calibration and using a total station for indoor applications, F Keller, H Sternberg, Remote sensing 5 (11), 5805-5824, 2013
Further information	-

Compulsory elective modules in the discipline of Geoinformatics

GEO.21.005 Spatial Databases

Module title (German)	Geodatenbanken
Responsibilities	Professor of photogrammetry, remote sensing, GIS and cartography
Credits	6
Courses	GEO Master of Geomatics Compulsory elective module in the discipline of Geoinformatics in semester 2 2021
Recurrence frequency and duration	Start of every winter semester over one semester
Prerequisite	None

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AHA15 Assignment of approx. 15 pages (weighting 75%) and AP15 Presentation of approx. 15 minutes (weighting 25%)
Assessment prerequisite	Successful participation in the tutorials, verified by submission of reports. Completeness and quality will be assessed by the lecturer.

Classes and workload

I	GEO.21.005.1	Spatial Databases Lecture, 2 CH	32 h
II	GEO.21.005.2	Spatial Databases Tutorial, 2 CH	32 h
III		Autonomous preparation/follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of photogrammetry, remote sensing, GIS and cartography
Teaching language	English
Contents	The classes cover: - Principles of relational and spatial database management systems (DBMS) - Spatial data in DBMS - Modelling of spatial data (development of specialist data models) - Administration of geodata - Model of spatial objects (ISO 19107 Spatial Schema, OGC Simple Feature model, SQL/MM Spatial) - Requesting spatial data; methods of spatial data analysis (geometry and topology) - Computerised methods for algorithmic geometry; indexing concepts The tutorial covers: - As part of hands-on projects, the students will develop and implement their own object-relational spatial database model which will be used to implement solutions to real-world issues - Data entry, management and searching - Application of various methods of data analysis in regard to real-world spatial issues When completing tutorials and projects, standards for scientific work and principles of presentation technology are taught and applied.

Learning objectives / outcomes	After completing the module, the students will be able to: - Summarise the principles of spatial database management systems and be aware of their advantages - Formulate problems, structure and model their own (spatial) data - Perform spatial and non-spatial data analyses on a database level The students will acquire an overview of spatial databases within GIS environments.
Teaching and learning formats	- Lecture on whiteboard, projector, computer, work sheets - Completion of practical exercises and typical applications in projects; use of open data and internal data, if necessary, data acquisition in the immediate surrounds of the University - Student's own practical projects that will be completed and presented before the participants - Self-study for preparation and follow-up; supervised individual investigations to expand and consolidate understanding - The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.
Literature	- Obe, Regina O., Hsu, Leo (2014): PostGIS in Action. Manning Publications. - Corti, Paolo, Kraft, Thomas J., Mather, Stephen V., Park, Bborie (2014): PostGIS Cookbook; Packt Publishing. - Brinkmann, T. (2013): Geodatenbanksysteme in Theorie und Praxis. Wichmann. - Rigaux, P., Scholl, M.O., Voisard, A. (2002): Spatial Databases with Applications to GIS. Morgan Kaufmann. Additional literature will be announced in the lecture.
Further information	-

GEO.21.008 Spatial Data Infrastructure

Module title (German)	Geodateninfrastruktur		
Responsibilities	Prof. of photogrammetry, remote sensing, GIS, cartography		
Credits	6		
Courses	LGM	Master Landscape Studies and Greenspace Management Compulsory elective module in semester 1	2020
	GEO	Master of Geomatics Compulsory elective module in the discipline of Geoinformatics in semester 1	2021
Recurrence frequency and duration	Start of every summer semester over one semester		
Prerequisite	None		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Accepted paper on the student's own project. Examination by the lecturers.

Classes and workload

I	GEO.21.008.1	Spatial Data Infrastructure Lecture, 2 CH	32 h
II	GEO.21.008.2	Spatial Data Infrastructure Tutorial, 2 CH	32 h
III		Independent project work	30 h
IV		Autonomous preparation/follow-up including exam preparation	86 h
		Total:	180 h

Teaching staff	N.N.
Teaching language	English
Contents	The classes cover: - Composition and structure - References and standards - Networks - Legal provisions - Responsibilities - Software solutions The tutorial covers: - Structure of a small system - Recording of geometrical and factual data - Client-server connection to databases - Incorporation of WMS and WFS - Design of the data portal
Learning objectives / outcomes	After completing the module, the students will be able to:

	- Explain the concept of geodata infrastructure (GDI) and its implementation at European, national, state and community levels - Describe the references and standards applicable for GDI - Differentiate the GDIs operated in the state of Mecklenburg-Vorpommern - Familiarise with important software solutions for GDI - Administer a community geodata portal, particularly to connect or disconnect technical data servers - Program minor query functions and assign user rights
Teaching and learning formats	In the lectures the usual didactic aids, including the internet, will be used. The practical sessions will be done on the computers and include the merging of several sources of data.
Literature	Zurbarán, Mayra, Kraft, Thomas, Mather, Stephen Vincent (2018): PostGIS Cookbook: Store, organize, manipulate, and analyze spatial data, Packt Publishing, UK Kresse, Wolfgang, Danko, David (2012): Handbook of Geographic Information, Springer Mitchell, Tyler, Emde, Astrid, Christl, Arnulf (2008): Web-Mapping mit Open Source-GIS-Tools. O'Reilly La Beaujardiere, Jeff de (2004): Web Map Service Implementation Specification (WMS), Open Geospatial Consortium-Dokument 04-024 Vretanos, Peter (2004): Web Map Feature Service Implementation Specification (WFS), Open Geospatial Consortium-Dokument 04-094 Additional literature will be announced in the lecture (current research articles, etc.)
Further information	-

GEO.21.013	Computer Graphics Project in Geoscience		
Module title (German)	Computer Grafik Projekt in Geowissenschaften		
Responsibilities	Professor of metrology and informatics		
Credits	6		
Courses	LGM	Master Landscape Studies and Greenspace Management Compulsory elective module in semester 1 or 2	2020
	GEO	Master of Geomatics Compulsory elective module in the discipline of Geoinformatics in semester 2	2021
Recurrence frequency and duration	Start of every winter semester over one semester		
Prerequisite	None		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	SCH120 Written examination of 120 minutes' duration
Assessment prerequisite	Accepted paper on the student's own project. Examination by the lecturers.

Classes and workload

I	GEO.21.013.1	Computer Graphics Project in Geoscience Lecture, 2 CH	32 h
II	GEO.21.013.2	Computer Graphics Project in Geoscience Tutorial, 2 CH	32 h
III		Independent project work	30 h
IV		Autonomous preparation and follow-up including exam preparation	86 h
		Total:	180 h

Teaching staff	Professor of metrology and informatics
Teaching language	English
Contents	The classes cover: - Modern digital geometric object descriptions - Georeferencing, geomesh tesselation and tiling - Coordination transformations, point cloud import from laser scanning and photogrammetry - Render pipelines - Streaming multiprocessing - Shader and nodes - Ray tracing - Compositing - Interactive data visualisation - Real-time requirements - Strategies for managing and securing large data volumes The tutorial covers: Completion of a semester project accompanying the lectures in the area of geodata visualisation

Learning objectives / outcomes	After completing the module, the students will be able to: - Describe current procedures and methods in digital geometric object descriptions and their 3D visualisation options - Prepare specifications and implement solutions for practical visualisation tasks in the geo area - Estimate the required hardware and software needs for specific accuracy requirements The students will be familiar with procedures for handling locally incomplete information in the area of geodata visualisation. The students will have experience in managing and securing large data volumes.
Teaching and learning formats	In the lectures the usual didactic aids, including the internet, will be used. The practical sessions are completed on the computer system of the University.
Literature	Literature will be announced in the lecture (data sheets, technical specifications, current research articles, etc.)
Further information	-

GEO.21.017 GI Technologies

Module title (German)	GI Technologien
Responsibilities	Professor of photogrammetry, cartography, GIS and remote sensing
Credits	6
Courses	GEO Master of Geomatics Compulsory elective module in the discipline of Geoinformatics in semester 2 2021
Recurrence frequency and duration	Start of every winter semester over one semester
Prerequisite	None

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AHA15 Assignment of approx. 15 pages (weighting 75%) and AP15 Presentation of approx. 15 minutes' duration (weighting 25%)
Assessment prerequisite	Successful completion of the seminar tasks. Examination by the lecturers.

Classes and workload

I	GEO.20.017.1	GI Technologies Tuition in seminars, 4 CH	64 h
II		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of photogrammetry, cartography, GIS and remote sensing
Teaching language	English
Contents	The classes include a highly practical approach. The students work through issues across a range of subjects. In theory this includes an overview of current trends and developments in geoinformatics, particularly issues related to GIS and remote sensing (e. g. mobile and web-based GIS, OpenData, free and open-source software (FOSS), various sensor systems); use of these technologies in various land management systems by way of example. The tutorials cover, among other elements, projects from land use management, risk management, agriculture, urban development, development collaboration, health management, tourism, resource planning and geology as well as archaeology and route research. When completing tutorials and projects, standards for scientific work and principles of presentation technology are taught and applied.
Learning objectives / outcomes	The students acquire an overview of the current status of GIS and remote sensing. Depending on the selected themes (such as risk management, Web-GIS or OpenStreetMap), the students will be familiar with the particular principles and the techniques required.
Teaching and learning formats	Lecture or interactive completion of various thematic issues on whiteboard, projector, computer and work sheets to present the contents; in the lectures the particular theoretical principles of the applications that are implemented in the individual tutorials will be discussed;

- independently performed data acquisition (e. g. mapping),
- guided self-study; and
- completion and presentation of the student's own project.

The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.

Literature

Various publications on the different topics in the class, e. g.:

- Konecny, Milan (2010): Geographic information and cartography for risk and crisis management: towards better solutions. Springer Verlag
- Ramm F., Topf J.(2010): OpenStreetMap: Die freie Weltkarte nutzen und mitgestalten. Lehmans Media Verlag, 3rd edition.
- Schweikart, Jürgen (2004): Geoinformationssysteme im Gesundheitswesen: Grundlagen und Anwendungen. Wichmann Verlag
- Sherman, G.E. (2008): Desktop GIS – Mapping the Planet with Open Source Tools. O'Reilly;
- Liu, Jian Guo (2016): Image processing and GIS for remote sensing – techniques and applications. Wiley-Blackwell.
- Wegmann, M., Leutner B. & Dech, S. (2016). Remote Sensing and GIS for Ecologists – using open source Software. Data in the wild, Pelagic Publishing.

Additional literature will be announced in the lecture depending on the thematic issue.

Further information

GEO.21.040 Remote Sensing

Module title (German)	Fernerkundung		
Responsibilities	Prof. of photogrammetry, remote sensing, GIS, cartography		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory elective module in the Geodesy discipline in semester 2	2021
Recurrence frequency and duration	Start of every winter semester over one semester		
Prerequisite	None		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	M30 Oral examination of approx. 30 minutes' duration
Assessment prerequisite	Evidence of participation in laboratory tasks and accepted written reports and presentations of exercises. Examination by the lecturers. More detailed provisions are contained in section 4 of the departmental examination regulations.

Classes and workload

I	GEO.21.040.1	Remote Sensing Lecture, 2 CH	32 h
II	GEO.21.040.2	Remote Sensing Tutorial, 2 CH	32 h
III		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of photogrammetry, remote sensing, GIS and cartography
Teaching language	English
Contents	Lecture:

1. Introduction to remote sensing
2. Interaction between electromagnetic radiation and materials
3. Data on the interaction between wave radiation and natural objects
4. Evidence of electromagnetic radiation
5. Processing remote sensing data
6. Image features
7. General methods for interpreting remote sensing images
8. Data analysis, including classification with modern methods
9. Interpretation of remote sensing data for feature mapping and land evaluations
10. Optoelectronic remote sensing
11. Heat-infrared remote sensing
12. Microwave remote sensing
13. Applications
14. In-situ calibration and validation (field exercises)

	Practical training: Application of specific software packages and programming exercises related to the above topics;
Learning objectives / outcomes	Design of a remote sensing processing and/or a remote sensing processor as well as sustainable data retention can be implemented in practice; various data collection methods and analytical methods can be adequately used; The participants obtain a critical methodological awareness related to remote sensing and an advanced ability to solve problems as well as advanced communication skills in this regard; the students are able to evaluate and implement the necessary procedures that are required to obtain information and the physical principles required for this are familiar to them.
Teaching and learning formats	Lecture on whiteboard, projector, computer, work sheets; if necessary, data acquisition as part of national and international field campaigns (e. g. TERENO, JECAM in the DEMMIN test site, MV); Work placement: Programming of new and application of prescribed software Self-study for preparation and follow-up The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers. Self-study for preparation and follow-up;
Literature	Kramer, H. J. (1996): Observation of the Earth and its environment. Survey of missions and sensors. – 580 pp, Springer Verlag (Berlin, Heidelber, etc.); ISBN: 3-540-57858-7 Kraus, K. & Schneider, W. (1988): Fernerkundung. Band 1: Physikalische Grundlagen und Aufnahmetechniken. – 300 pp, Dümmler Verlag (Bonn); ISBN: 3-427-78661-7 Lillesand, T.M.; R.W. Kiefer, and J.W. Chipman (2003). Remote sensing and image interpretation, 5th ed., Wiley. ISBN 0-471-15227-7. Richards, J.A.; and X. Jia (2006). Remote sensing digital image analysis: an introduction, 4th ed., Springer. ISBN 3-540-25128-6. Sabins, F. F. (1997): Remote sensing: Principles and interpretation. - 3rd ed., 450 p., Freeman Press (San Francisco). Schowengerdt, R.A. (1997): Remote Sensing: Models and Methods for Image Processing. - 2nd ed., 525 p. Academic Press. Additional literature will be announced in the first lecture
Further information	

GEO.21.050 GIS and remote sensing for sustainable land and risk management

Module title (German)	GIS & Fernerkundung für Land- und Krisenmanagement		
Responsibilities	Professor of photogrammetry, cartography, GIS and remote sensing		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory elective module in the Geodesy discipline in semester 1	2021
Recurrence frequency and duration	Start of every summer semester over one semester		
Prerequisite	None		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AHA15 Assignment of approx. 15 pages (weighting 75%) and AP15 Presentation of approx. 15 minutes' duration (weighting 25%)
Assessment prerequisite	Collaboration in the tutorials as well as recognised written reports and presentations on individual tutorial tasks. Examination by the lecturers.

Classes and workload

I	GEO.21.050.1	GIS and remote sensing for sustainable land and risk management Lecture 1 CH	16 h
II	GEO.21.050.2	GIS and remote sensing for sustainable land and risk management Tuition in seminars 2 CH	32 h
III	GEO.21.050.3	GIS and remote sensing for sustainable land and risk management Tutorial, 1 CH	16 h
IV		Autonomous preparation/follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of photogrammetry, cartography, GIS and remote sensing
Teaching language	English
Contents	The classes cover: - General principles of the concepts behind land and crisis management systems - Investigations of issues relating to natural and anthropogenic risks - Theoretical consideration of various natural hazards - Theory of hazards, vulnerabilities and risk - Analytical methods: imprecise quantities and weighting (vulnerability analysis) and statistical analyses (hazard analysis) - Consideration of existing systems and international organisations as well as presentation of a number of practical national and international examples

The tuition in seminars includes detailed theoretical consideration of different natural hazards (e. g. flooding, flash floods, epidemics, earthquakes, volcanos, wildfires, mass migrations) and elaboration of the particular associated parameters.

The tutorial covers:
- Application of the theoretical principles, particularly the vulnerability analysis and hazard analysis; the risk assessment is generated from these two parts
- Search and use of free data
- Analysis, particularly of remote sensing data
- Construction of GIS on practical real and current examples with free and open-source software (FOSS)

In the completion of the projects and presentations, standards for scientific work and principles of presentation technology are taught and applied.

Learning objectives / outcomes

After completing the module, the students will be able to differentiate between hazards, vulnerabilities and risks and identify important relevant local, national and international platforms and data sources. They will master qualitative raster-based analytical methods and the concept of fuzzy quantities.
They are able to develop autonomous concepts for risk assessments of natural and anthropogenic hazards and to perform fundamental analyses.

Teaching and learning formats

- Lecture on whiteboard, projector, computer, work sheets
- Carrying out practical exercises for the individual analytical methods in projects; use of open data, particularly satellite data, and free software products (FOSS)
- Tuition in seminars with presentations by students on the various natural hazards; presentation of the results from the tutorials and the student's own project
- Supervised individual investigations to expand and consolidate understanding
- Completion of an independent project on a concrete natural or anthropogenic hazard in a defined region
- If possible, excursion(s) to various organisations, institutions or companies such as GFZ Potsdam (early warning systems), German tourism association DTV (risk monitoring in the industry), Munich Re, A3M Global Monitoring
- The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.

Literature

Various publications on the different topics in the class, e. g.:
- Konecny, Milan (2010): Geographic information and cartography for risk and crisis management: towards better solutions. Springer Verlag
- Ramm F., Topf J.(2010): OpenStreetMap: Die freie Weltkarte nutzen und mitgestalten. Lehmans Media Verlag, 3rd edition.
- Schweikart, Jürgen (2004): Geoinformationssysteme im Gesundheitswesen: Grundlagen und Anwendungen. Wichmann Verlag
- Wegmann, M., Leutner B. & Dech, S. (2016). Remote Sensing and GIS for Ecologists – using open source Software. Data in the wild, Pelagic Publishing.

Articles:
- Eastman (1999): Multi-criteria evaluation and GIS. Geographical information systems, 1(1), 493–502.
- Greene, R., Devillers, R., Luther, J. E., & Eddy, B. G. (2011). GIS-based multiple-criteria decision analysis. Geography compass, 5(6), 412–432.
- Malczewski, J., & Rinner, C. (2015). Introduction to GIS-mcda. In Multicriteria Decision Analysis in Geographic Information Science (pp. 23–54). Springer, Berlin, Heidelberg.

Additional literature will be announced in the lecture.

Further information

GEO.21.053 Earth Observation and Space Weather Impact

Module title (German)	Erdbeobachtung und Weltraumwetter		
Responsibilities	Professor of applied and practical informatics		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory elective module in the discipline of Geoinformatics in semester 1	2021

Recurrence frequency and duration	Starts every summer semester over one semester
Prerequisite	Good knowledge of physics and mathematics is recommended

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AHA10 Assignment (academic article) of at least 10 pages (weighting: 80%) and AP30 Presentation of the results of 30 minutes' duration (weighting 20%)
Assessment prerequisite	Evidence of attendance at tuition in seminars. Successful completion of the tutorial tasks and delivery of interim presentations. The examination is administered by the lecturers. Section 4 of the departmental examination regulations applies.

Classes and workload

I	GEO.21.053.1	Earth Observation and Space Weather Impact Tuition in seminars, 2 CH	32 h
II		Scientific treatment of relevant issues related to the specified contents with interim presentations	64 h
III		Independent analysis, research and treatment of an individual scientific topic in the area of earth observation or space weather	64 h
IV		Autonomous preparation/follow-up including exam preparation	20 h
		Total:	180 h

Teaching staff	Scientists from the DLR (German Aerospace Center) Neustrelitz
Teaching language	Primary teaching language English
Contents	The classes cover: - The Earth-Sun system - Sporadic and massive eruptions of very high energy material and solar radiation - Modelling of processes within and between the thermosphere, ionosphere and magnetosphere - Impacts of these processes on technical systems and life on Earth - Sensors, methods and applications - Current earth observation systems and missions - Space-weather-related ground- and space-supported observations

	- Techniques and challenges associated with accessing, collecting, processing and presenting data - Methods for measuring, evaluating and predicting impacts - Current and future issues and needs relating to earth observation and space weather - Existing and upcoming earth observation and space weather services
Learning objectives / outcomes	The students will be familiar with and understand important processes in the Earth-sun system as well as current and future challenges in earth observation and space weather. They can apply and interpret physically based methods for modelling the Earth-sun system. They are familiar with and understand important measuring methods and can evaluate and process data obtained from the systems.
Teaching/learning formats*	- Tuition in seminars to present and explain the most important material using presentations and current scientific results using projector and whiteboard - Independent treatment of scientific issues based on given approaches and presentation of the findings - Supervised preparation of an academic article on a current topic The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.
Literature*	- Current academic literature and articles
Further information*	

Compulsory elective modules in the discipline of Informatics

GEO.21.022 Data Mining

Module title (German)	Datenanalyse / Wissensverarbeitung
Responsibilities	Prof. of mathematics, geometry and applied informatics
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the discipline of Informatics in semester 1
Recurrence frequency and duration	starts every summer semester over one semester
Prerequisite	Mathematics at the level of the Bachelor courses Geoinformatics as well as Geodesy and Metrology is recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AHA8 Research project of at least 8 pages
Assessment prerequisite	Evidence of participation in the tutorials and preparation of reports. Examination by the lecturers. Section 4 of the departmental examination regulations applies.

Classes and workload

I	GEO.21.022.1	Data Mining Lecture, 2 CH	32 h
II	GEO.21.022.2	Data Mining Tutorial, 2 CH	32 h
IIII		Autonomous preparation and follow-up	116 h
		Total:	180 h

Teaching staff	Prof. of mathematics, geometry and applied informatics
Teaching language	Primary teaching Language English
Contents	The classes cover: - Geometric characterisation of data - Classification methods - Pattern recognition - Machine learning
Learning objectives / outcomes	After completing the module, the students will be able to: - Handle and apply formulas and algorithms for classification and pattern recognition taking into account the computer technology - Understand the theoretical principles required for this
Teaching and learning formats	The module contents are taught in the lectures using whiteboard, PC and projector. In the tutorials, joint examples and tasks based on the lecture material are formulated and solved individually or in groups. Guided self-study for preparation and follow-up

Literature	Bishop, C. M.: Pattern recognition and machine learning, Springer 2006 Additional literature will be announced in the lecture
Further information	-

GEO.21.026 Multimedia

Module title (German)	Multimedia		
Responsibilities	Professor of practical geodesy, data processing and cartography		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory elective module in the discipline of Informatics in semester 1	2021

Recurrence frequency and duration	starts every summer semester over one semester
Prerequisite	Comprehensive knowledge of object-oriented programming is recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AP Writing and documentation of software
Assessment prerequisite	None

Classes and workload

I	GEO.21.026.1	Multimedia Lecture, 2 CH	32 h
II	GEO.21.026.2	Multimedia Tutorial, 2 CH	32 h
IV		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of practical geodesy, data processing and cartography
Teaching language	English
Contents	The classes cover: - Media and data law - Data formats in the media sector - Basic graph algorithms - Mobile computing - Security aspects - Storage networks - Web technologies for real and virtual worlds - 3D animation with a game engine
Learning objectives / outcomes	After completing the module, the students will be able to: - Demonstrate more in-depth knowledge of media and data law - Program interactive multimedia processes on websites or on mobile devices - Program virtual worlds in a game engine
Teaching and learning formats	Lecture on whiteboard, projector and in computer lab to present the contents of the seminars based on concrete tasks from nature, technology and the environment
Literature	Announced in the first lecture
Further information	-

GEO.21.051 Software Engineering

Module title (German)	Software Technik		
Responsibilities	Professor of applied and practical informatics		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory elective module in the discipline of Informatics in semester 1	2021
Recurrence frequency and duration	Start of every summer semester over one semester		
Prerequisite	Basic programming knowledge required.		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AP10 Independent design and implementation of a selected project and documentation of at least 10 pages, 80% and AP30 Presentation of the results of 30 minutes' duration, 20% The topic for the project for individual students will be specified at the start of the module. The lecturer handles the results of the project and the written report.
Assessment prerequisite	Collaboration in the tutorials as well as recognised solutions for the assignments and interim presentations for the project. Examination by the lecturers.

Classes and workload

I	GEO.21.051.1	Software Engineering Tuition in seminars, 2 CH	32 h
II		Independent project work	108 h
III		Autonomous preparation and follow-up including exam preparation	40 h
		Total:	180 h

Teaching staff	Professor of applied and practical informatics, among others
Teaching language	English
Contents	- Classical and agile procedure model of software development and its classification and evaluation - Specific aspects of planning and management of software projects - Architecture model and technologies for modelling - Design pattern and its application - Planning and execution of automatic tests - Software metrics and quality assurance (clean code) - Development and Operations (DevOps) - CI/CD (Continuous Integration, Continuous Deployment) - Modern methods and tools for development (incl. ticket systems, version management, etc.) - Methods for reverse engineering - Licensing models - Risk and threat assessment - Legal and ethical consequences of software use

- Implementation of learnt material using a practical task

Learning objectives / outcomes	The students will be familiar with essential concepts, methods and procedural models for the design, planning, development and management of complex software projects. They will be familiar with metrics to evaluate the quality of software, be able to estimate risks and threats in development and the use of complex software systems and know how these can be minimised.
Teaching and learning formats	In the tuition in seminars, the various issues will be dealt with jointly. The most important principles and models will be presented by the lecturers. The students will conduct independent research on selected issues and present the results to the group, which will then discuss the results. Throughout the module, a more complex project will be analysed, designed and planned by way of example in small groups using a suitable practically relevant problem with the learnt material being applied and consolidated in the process. Using interim presentations, project discussions and consultations throughout the module, the learning and work progress will be continually advanced. The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.
Literature	- In-house scripts - Relevant current publications or documentation
Further information	

GEO.21.033 Software Project

Module title (German)	Software-Projekt
Responsibilities	Professor of applied and practical informatics
Credits	6

Courses	GEO	Master of Geomatics Compulsory elective module in the discipline of Informatics in semester 2	2021
Recurrence frequency and duration	Start of every winter semester over one semester		
Prerequisite	Basic programming knowledge required		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AP10 Independent design and implementation of a programming solution to parallelise a selected problem and documentation of at least 10 pages (weighting 75%) and AP30 Presentation of the results of 30 minutes' duration (weighting 25%) The topic for the project for individual students will be specified at the start of the module. The presentation covers the results of the project and the written report.
Assessment prerequisite	Collaboration in the tutorials as well as recognised solutions for the assignments and interim presentations for the project.

Classes and workload

I	GEO.20.033.1	Software Project Seminar, 1 CH	16 h
II		Independent project work	114 h
III		Preparation of the documentation and the presentations	28 h
IV		Preparation and follow-up including exam preparation	20 h
		Total:	180 h

Teaching staff	Professor of applied and practical informatics
Teaching language	English
Contents	- Analysis, planning and implementation of an application-oriented software project - Project management and work - Application of the course materials to discipline-specific problems from science and practice - Development of project-dependent specialist knowledge - Project management - Independent development of projects
Learning objectives / outcomes	The students will have consolidated experience in the analysis, planning, development, implementation and presentation of complex application-related software in the area of geoinformatics and/or applied informatics. They will independently solve challenging tasks and apply modern software technologies.

Teaching and learning formats	- Tuition in seminars and interim presentations - Project discussions and consultations - Independent project work in laboratories or with project partners - Independent research, design and implementation - Supervised treatment of an individual problem The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.
Literature	- Online documentation of algorithms and sample solutions - In-house scripts - Relevant current publications or documentation
Further information	

GEO.21.034 Parallel Computing

Module title (German)	Paralleles Rechnen
Responsibilities	Professor of applied and practical informatics
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the discipline of Informatics in semester 2
Recurrence frequency and duration	Start of every winter semester over one semester
Prerequisite	Solid programming knowledge, principles of shell programming recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AP6 Independent design and implementation of a technical programming solution to parallelise a selected algorithm and documentation of at least 6 pages (weighting 75%) and AP15 Presentation of the results of 15 minutes' duration (weighting 25%) The topic for the individual report for each student will be specified during the module. The presentation covers the topic of the written report.
Assessment prerequisite	Collaboration in the tutorials as well as recognised solutions for the assignments and interim presentations for the project. The examination is administered by the lecturers. Section 4 of the departmental examination regulations applies.

Classes and workload

I	GEO.21.034.1	Parallel Computing Tuition in seminars, 2 CH	32 h
II	GEO.21.034.2	Parallel Computing Tutorial, 2 CH	32 h
IIII		Independent parallelising project	82 h
IV		Autonomous preparation/follow-up including exam preparation	34 h
		Total:	180 h

Teaching staff	Professor of applied and practical informatics
Teaching language	English
Contents	Part 1 (tuition in seminars) - Hardware basics: level of parallelism, processors, multi-processor systems, parallel computers, storage models - Machine and programming models for parallel processing - Basic concepts of parallel programming - Typical examples of parallelisation of algorithms - Methods and technologies for synchronisation - Deadlocks and avoiding deadlocks - Parallelising at process level (shell scripting) - Thread programming; OpenMP; GPGPUs - Cluster programming with MPI - Performance assessment and estimate

- Analysing, profiling and optimising software regarding storage and run-time efficiency
- Current developments

Part 2 (tutorial)
- Introduction to C
- Thread programming (Java or the like) and pthreads
- Parallelising simple example algorithms
- Synchronising the work of parallel units
- Run-time measurements and evaluation
- Troubleshooting / optimisation

Learning objectives / outcomes	The students will understand the basic requirements for and approaches to accelerating the technical programming implementation of algorithms using parallelisation. They will be familiar with the structure of parallel computers as well as the development of parallel programs and are able to recognise opportunities to accelerate algorithms or practical problems as well as to independently design and implement solutions.
Teaching and learning formats	- Tuition in seminars to present and explain the most important material using presentations and example programs on projector and whiteboard - Carrying out practical exercises by jointly working through sample solutions on PCs as well as on a virtual and a real cluster in the PC pool or a project laboratory - Independent completion of assignments based on specified sample solutions - Supervised treatment of an individual problem with interim presentations to expand and consolidate understanding The e-learning platform of the University will be used to provide supplementary information and tasks and for the assessment of the practical papers.
Literature	- Barney: Introduction to Parallel Computing, Lawrence Livermore National Laboratory (online) - Dongorra, Foster, Fox et al: Sourcebook of parallel computing; Morgan Kaufmann - Grama, Gupta et al: Introduction to Parallel Computing, Addison Wesley - Pacheo: An Introduction to Parallel Programming, Elsevier - Rauber, Rünger: Parallel Programming for Multicore and Cluster Systems; Springer - MPI documentation (online) - Online documentation of algorithms and sample solutions - In-house scripts - Current documentation from program languages and libraries used
Further information	

GEO.21.001 Higher Mathematics

Module title (German)	Höhere Mathematik
Responsibilities	Prof. of mathematics, geometry and applied informatics
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the Geodesy discipline in semester 1
Recurrence frequency and duration	starts every summer semester over one semester
Prerequisite	Mathematics and geometry at the level of the Bachelor courses Geoinformatics as well as Geodesy and Metrology is recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	SCH120 Written examination of 120 minutes' duration
Assessment prerequisite	None

Classes and workload

I	GEO.21.001.1	Higher Mathematics Lecture, 2 CH	32 h
II	GEO.21.001.2	Higher Mathematics Tutorial, 2 CH	32 h
IIII		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Prof. of mathematics, geometry and applied informatics
Teaching language	Primary teaching Language English
Contents	The classes cover: - Solution behaviour for linear equation systems - Intrinsic values and vectors - Differential and integral calculus of several variables - Fields and tensors - Conventional differential equations - Implementation of these subjects with mathematical software
Learning objectives / outcomes	After completing the module, the students will be able to: - Demonstrate skills in and knowledge of the handling of formulas and algorithms taking into account the computer technology - Understand the theoretical principles required for this
Teaching and learning formats	The module contents are taught in the lectures using whiteboard, PC and projector. In the tutorials, joint examples and tasks relating to the module material are formulated and solved individually or in groups. Guided self-study for preparation and follow-up.

Literature	Additional literature will be announced in the lecture
Further information	-

GEO.21.025 Geostatistics

Module title (German)	Geostatistik
Responsibilities	Professor of practical geodesy, data processing and cartography
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the Mathematics discipline in semester 1
Recurrence frequency and duration	starts every summer semester over one semester
Prerequisite	Passed examination of a module of spatial statistics (Bachelor) is required.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	AHA15 Assignment of approx. 15 pages.
Assessment prerequisite	None

Classes and workload

I	GEO.21.025.1	Geostatistik Lecture, 2 CH	32 h
II	GEO.21.025.2	Geostatistik Seminar, 2 CH	32 h
IIII		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of practical geodesy, data processing and cartography
Teaching language	English
Contents	The classes cover: - Multivariate geostatistics - Optimal test network planning - Methods for geostatistical prediction and geostatistical simulation - Models and algorithms for data processing - Bayesian statistics
Learning objectives / outcomes	After completing the module, the students will be able to: - Analyse and evaluate n-dimensional data - Select the optimal estimation method based on different parameters - Estimate parameters for spatial dependencies - Make statements about extreme values based on conditional geostatistical simulations - Consider fuzzy data quantities in the forecast - Answer various technical spatially related questions
Teaching and learning formats	Lecture on whiteboard, projector and in computer lab to present the contents of the seminars with concrete examples from nature and the environment, self-study for preparation and follow-up

Literature	Additional literature will be announced in the lecture
Further information	-

GEO.21.028 Differential Geometry

Module title (German)	Differenzialgeometrie
Responsibilities	Professor of mathematics, geometry and applied informatics
Credits	6
Courses	GEO Master of Geomatics 2021 Compulsory elective module in the Mathematics discipline in semester 2
Recurrence frequency and duration	Start of every winter semester over one semester
Prerequisite	Mathematics 1 and 2 from the Bachelor course 'Geoinformatics' and 'Geodesy and Metrology', including solving of equations, matrices, vectors, differential and integral calculus of one variable are recommended.

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	SCH120 Written examination of 120 minutes' duration
Assessment prerequisite	None

Classes and workload

I	GEO.21.028.1	Differential Geometry Lecture, 2 CH	32 h
II	GEO.21.028.2	Differential Geometry Seminar, 2 CH	32 h
IIII		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Professor of mathematics, geometry and applied informatics
Teaching language	Primary teaching language English
Contents	The classes cover: - Curves, especially surface curves - Geodesic lines - Metrics on curves, surfaces and manifolds - Curvature of curves and surfaces - Application in geodesy - Software implementation of these subjects
Learning objectives / outcomes	After completing the module, the students will be able to: - Handle formulas and algorithms taking into account the programming environment - Understand the theoretical principles required for this
Teaching and learning formats	The module contents are taught in the lectures using whiteboard, computer and projector. In the tutorials, examples and tasks for the lecture material are formulated jointly and solved individually or in groups. The tutorials are completed in computer laboratories.

Literature	Gray (various editions): Modern Differential Geometry of Curves and Surfaces, CRC Press Inc. Heitz (1988): Coordinates in Geodesy. Springer. Lipschutz (various editions): Theory and problems of differential geometry. Schaum's Outline. Additional literature will be announced in the lecture.
Further information	-

GEO.21.052 Numerical Analysis

Module title (German)	Numerische Mathematik
Responsibilities	Prof. of mathematics, geometry and applied informatics
Credits	6

Courses	GEO	Master of Geomatics Compulsory elective module in the Mathematics discipline in semester 1	2021
Recurrence frequency and duration	Starts every summer semester over one semester		
Prerequisites	Mathematics and geometry at the level of the Bachelor courses Geoinformatics as well as Geodesy and Metrology is recommended.		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessments	AP6 Independent design and implementation of a numerical algorithm as a solution to a specified problem including documentation of at least 6 pages (weighting: 75%) and AP15 Presentation of the results of 15 minutes' duration (weighting: 25%) The tasks are issued by the lecturers. The presentation includes the results of the numerical program and the submitted report.
Assessment prerequisites	Successful participation in the tutorials as assessed by the lecturers. Section 4 of the departmental examination regulations applies.

Classes and workload

I	GEO.21.052.1	Numerical Analysis Lecture, 2 CH	32 h
II	GEO.21.052.2	Numerical Analysis Tutorial, 2 CH	32 h
IIII		Autonomous preparation and follow-up including exam preparation	116 h
		Total:	180 h

Teaching staff	Prof. of mathematics, geometry and applied informatics
Teaching language	Primary teaching Language English
Contents	- Essential concepts in numerical mathematics (computer arithmetic, condition, stability, error propagation) - Methods to solve linear equation systems and non-linear equations - Interpolation - Numerical solving of differential equations - Numerical integration
Learning objectives / outcomes	After completing the module, the students will be familiar with the special features that are taken into account when applying numerical methods to solve mathematical tasks and can thus estimate the quality of numerical results.

Teaching/learning formats*	Lecture: The module contents are taught in the lectures using whiteboard, PC and projector. Tutorials: In the tutorials, examples and tasks for the lecture material are formulated jointly and solved individually or in groups. Self-study for preparation and follow-up
Literature*	M. Knorrenschild: Numerische Mathematik. Eine beispielorientierte Einführung, Fachbuchverlag Leipzig G. Engeln-Müllges, K. Niederdrenk, R. Wodicka: Numerik-Algorithmen, Verfahren, Beispiele, Anwendungen, Springer-Verlag Heidelberg/Berlin Stoer, Bulirsch. Introduction to Numerical Analysis, Springer, 1980 .
Further information*	-

Compulsory modules

GEO.21.007 Application Project

Module title (German)	Anwenderprojekt		
Responsibilities	Professor of applied and practical informatics		
Credits	6		
Courses	GEO	Master of Geomatics Compulsory module in semesters 1 and 2	2021
Recurrence frequency and duration	starts every summer semester over two semesters		
Prerequisite	None		

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.	
Assessment	AP	Independent completion of a specified practical or scientific issue. Research, design and implementation of a solution (weighting: 75%)
	and	
	AP15	Presentation of the results of 15 minutes' duration (weighting: 25%) The presentation covers the results of the project and describes the essential contents of the written report.
	The individual topic will be selected and defined at the start of the module from a list of current topics. A project can be completed individually or in small groups depending on its size and complexity.	
Assessment prerequisite	Evidence of participation in the seminars for the interim presentations about the projects. Examination by the lecturers. More detailed provisions are contained in section 4 of the departmental examination regulations.	

Classes and workload

I	GEO.21.007.1	Application project Seminar, 1 CH	16 h
II		Independent project work	118 h
III		Autonomous preparation and follow-up including exam preparation	48 h
		Total:	180 h

Teaching staff	Professors in the course
Teaching language	English
Contents	The classes cover: - Application of the course materials to discipline-specific problems from science and practice - Development of project-dependent specialist knowledge - Project management - Preparation of the Master's thesis

Learning objectives / outcomes	After completing the module, the students will be able to: - Plan and complete challenging projects based on experience acquired to solve complex tasks in geodesy or geomatics - Independently solve sub-tasks and coordinate sub-tasks in teams.
Teaching and learning formats	- Tuition in seminars and interim presentations - Project discussions and consultations - Independent completion of a project in laboratories or with project partners - Independent research, design and implementation - Supervised treatment of an individual problem The e-learning platform of the University will be used to provide supplementary information and for the assessment of the submitted assignments.
Literature	- Online documentation of algorithms and sample solutions - In-house scripts - Relevant current publications or documentation
Further information	

GEO.21.090 Master's thesis with Master's colloquium

Module title (German)	Master-Arbeit mit Master-Kolloquium
Responsibilities	Course lecturers
Credits	30
Courses	GEO Master of Geomatics 2021 Compulsory module in semester 3
Recurrence frequency and duration	Starts every summer semester over one semester
Prerequisite	Evidence of at least 42 credits (as per section 8 of the departmental examination regulations)

Prerequisites for awarding credit points

Grade and calculation	The module is graded. The consideration of the module grade in the overall grade calculation can be found in the corresponding examination plan.
Assessment	MA60 Master's thesis of approx. 60 pages (weighting: 23 ECTS) and AKQ45 Master's colloquium of 45 minutes' duration (weighting: 7 ECTS)
Assessment prerequisite	None

Classes and workload

I	Master's thesis:	690 h
II	Master's colloquium	210 h
	Total:	900 h

Teaching staff	Professors in the course
Teaching language	Primary teaching language English or German Note in section 7 of the departmental examination regulations, paragraph 3.
Contents	Independent scientific or engineering completion of a task or problem at the level of a Master's degree.
Learning objectives / outcomes	The students will be able to structure and independently solve a scientific or engineering task in geoinformatics or geodesy and describe the solution in an appropriate written format and present the solution orally. Based on the knowledge acquired in the course, the students will be able to analyse problems, relate the problems to the current international body of knowledge based on the literature and internet, and implement a well-founded solution.
Teaching and learning formats	- Academic supervision of the subject in the form of consultations with the supervisor(s).
Literature	Current literature related to the topic
Further information	