UNIVERSITÄT BONN

landwirtschaftliche fakultät

module manual

master's program
Geodetic Engineering
(M.Sc. GE)

module list

UNIVERSITÄT BONN

landwirtschaftliche fakultät

module manual

master's program
Geodetic Engineering
(M.Sc. GE)

Allgemeiner Pflichtbereich /
general mandatory selection

Code: **MGE-01**
Title: **Coordinate Systems**

1 Content and intended learning outcomes

Content:

Euler angles; Quaternions; Homogeneous coordinates; Typical transformations (similarity, affine, projective); Local 3D Systems; Registration and georeferencing; Number of parameters depending on conditions; Concatenation of transformations; Transformation from GNSS to local systems; Global and local systems; UTM and Gauß-Krüger; Ellipsoids; International Terrestrial Reference Frame (definition, scale, datum, no-net-translation, no-net-rotation, velocity field, no-net-translation-rate, no-net-rotation-rate); Earth's motion in space; Earth-fixed and celestial coordinate systems; Global and local coordinate systems; Reference systems and reference frames; Projected coordinate systems in cartography and GIS; Map distortions and consequences for GIS-based computations

Qualification goals:

Acquisition of advanced knowledge and use of different 3D coordinate systems as well as different parameterizations for typical geodetic applications on local and global scales

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Coordinate Systems	en	20	1	45	W
2	Exercise, scientific	Coordinate Systems	en	20	1	45	W

3 Prerequisites to take part the module

obligatory:

none

recommended:

none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	General mandatory selection	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Written examination	written and/or verbal academic performance	120	graded	en	100 %

6 Credits according ECTS

3 LP

7 Workload

90 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	0.33	X	X
Dr.-Ing. Christoph Holst	Institut für Geodäsie und Geoinformation	0.67	X	X
Prof. Dr.-Ing. Jürgen Kusche	Institut für Geodäsie und Geoinformation	0.5	X	X
Prof. Dr.rer.nat. Cyrill Stachniss	Institut für Geodäsie und Geoinformation	0.5	X	X

Module coordinator / Organisation:
Prof. Dr.rer.nat. C. Stachniss (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
Förstner, W., Wrobel, B. P. (2016): Photogrammetric Computer Vision · Statistics, Geometry, Orientation and Reconstruction. Springer International Publishing. doi 10.1007/978-3-319-11550-4

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

22.10.2019

Code: **MGE-02**
Title: **Global Navigation Satellite Systems**

1 Content and intended learning outcomes

Content:
Basic principle of Global Navigation Satellite Systems; Coordinate systems, time systems, and satellite orbit representations; GNSS signals and receiver technology; Observables, atmospheric effects, and multipath; Positioning procedures: Single point positioning, relative GNSS with carrier phases, precise point positioning; RTK GNSS; Network GNSS; Kinematic GNSS; GNSS attitude determination; GPS, GLONASS, Galileo, and BeiDou; GNSS applications

Qualification goals:
Acquisition of advanced knowledge of the physical, functional, and stochastical characteristics of satellite-based positioning procedures and systems; In-depth knowledge of the structure and processing of GNSS signals; Skills in positioning with GNSS and performing absolute and relative GNSS measurements for static and kinematic applications; Understanding and interpretation of GNSS results and systematic deviations

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Global Navigation Satellite Systems	en	20	1	45	W
2	Exercise, practical	Global Navigation Satellite Systems	en	20	1	45	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	General mandatory selection	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Written examination	written and/or verbal academic performance	120	graded	en	100 %

6 Credits according ECTS

3 LP

7 Workload

90 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Dr.rer.nat. Lasse Klingbeil	Institut für Geodäsie und Geoinformation	1	X	X
Diana Becirevic M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. H. Kuhlmann (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:

Paul D. Groves (2007): Principles of GNSS, Inertial and multisensor navigation systems; Artech House Publishers, ISBN 1580532551, ISBN 13: 9781580532556

Seeber, G. (2008). Satellite Geodesy. Foundations, Methods, and Applications. Berlin, Boston: De Gruyter

Gilbert Strang, Kai Borre (1997): Linear Algebra, Geodesy, and GPS; Wellesley-Cambridge Press, ISBN 0-9614088-6-3

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

22.10.2019

Code: **MGE-03**
Title: **Statistics and Adjustment Theory**

1 Content and intended learning outcomes

Content:

Least Squares Estimation; Regression analysis; Probability theory (Random variables, probability distribution, statistic moments and their propagation); Best linear unbiased estimator (BLUE, Gauss-Markov-model); Confidence regions; Hypothesis testing

Qualification goals:

Acquisition of advanced knowledge about concepts in statistics, parameter estimation and hypothesistesting. Problem-solving abilities in order to independently solve practical adjustment problems shall beavailable after the module. In addition the ability to independently interpret the quality and reliability of adjustment results is aspired.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Statistics and Adjustment Theory	en	20	1	45	W
2	Exercise, scientific	Statistics and Adjustment Theory	en	20	1	45	W

3 Prerequisites to take part the module

obligatory:

none

recommended:

Basic knowledge on applied mathematics (analysis, linear algebra, numerics) and computing are recommended.

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	General mandatory selection	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Written examination	written and/or verbal academic performance	120	graded	en	100 %

6 Credits according ECTS

3 LP

7 Workload

90 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.techn. Wolf-Dieter Schuh	Institut für Geodäsie und Geoinformation	1	X	X
Dr.-Ing. Jan Martin Brockmann	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.techn. W.-D. Schuh (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
Koch, K.R. (1999): Parameter Estimation and Hypothesis Testing in Linear Models. Springer.
Meissl, P. (1982): Least squares adjustment: A modern approach. Mitteilungen der Geodätischen Institute der TU Graz, Folge 43.

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

22.10.2019

Code: **MGE-04**
Title: **Computational Foundations of GIS**

1 Content and intended learning outcomes

Content:
Foundations of geoinformation systems; Vector and raster models; Spatial referencing of objects in geoinformation systems; Metric spaces; Topological spaces and topological relations; Object-oriented modeling of geoinformation; Spatial databases; Spatial queries; Geometric algorithms for spatial analysis

Qualification goals:
Acquisition of advanced competences in developing and using geoinformation systems for problems of spatial analysis. Successful candidates are able to handle different data formats, to design spatial databases, and to query databases to answer questions about non-spatial and spatial relations between objects.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Geoinformation Systems	en	20	1	45	W
2	Exercise, scientific/practical	Geoinformation Systems	en	20	1	45	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	General mandatory selection	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

3 LP

7 Workload

90 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	1	X	X
Dr.-Ing. Youness Dehbi	Institut für Geodäsie und Geoinformation	0.5	X	
Johannes Oehrlein M.Sc.	Institut für Geodäsie und Geoinformation	0.5	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J.-H. Haunert (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:

Worboys, Michael F. and Matt Duckham (2004): GIS – a Computing Perspective. 2nd Edition, CRC Press. ISBN:0415283752

Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (2009): Introduction to Algorithms. 3rd Edition, MIT Press. ISBN: 9780262533058

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

22.10.2019

Code: **MGE-05**
Title: **Geodetic Earth Observation**

1 Content and intended learning outcomes

Content:
Concepts of global reference systems and reference frames; Representation of Earth rotation and Earth orientation parameters (EOPs); Concepts of reference ellipsoid, geoid, and gravity field; Satellite orbits for geodesy and remote sensing (Kepler and J2 effects); Basics of space-geodetic observing techniques; Propagation of electromagnetic waves; Atmosphere; Principles of timing systems; Space environment

Qualification goals:
Advanced comprehension of fundamental concepts in global geodesy and geodetic Earth observation.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Geodetic Earth Observation	en	20	1	45	W
2	Exercise, scientific	Geodetic Earth Observation	en	20	1	45	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	General mandatory selection	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

3 LP

7 Workload

90 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Dr.-Ing. Makan Karegar	Institut für Geodäsie und Geoinformation	1	X	X
Dr.-Ing. Roelof Rietbroek	Institut für Geodäsie und Geoinformation	1	X	X

Module coordinator / Organisation:
Prof. Dr.-Ing. J. Kusche (Institut für Geodäsie und Geoinformation)

12 **Further information**

Optional excursion (Potsdam)
References:
Heiskanen and Moritz (1967): Physial Geodesy, https://archive.org/details/heiskanen_morits_1967_physical_geodesy
Torge, W. & Müller, J. (2012): Geodesy, 4th edition. Berlin, Boston: DeGruyter
Seeber, G. (2008). Satellite Geodesy. Foundations, Methods, and Applications. Berlin, Boston: De Gruyter

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

22.10.2019

Code: **MGE-06**
Title: **Profile Fundamentals**

1 Content and intended learning outcomes

Content:
Additional learning objectives regarding the chosen profile, according to the students' competences.
Topics are chosen from a predefined list of required competences regarding the main profile:
· Profile Mobile Sensing and Robotics: Random and systematic measurement error; Variance propagation; Probability basics (conditioning, marginali-zation, independence, Bayes' rule); Bayes filter basics; Traverses; Total stations (angular measurements, elec-tro-optical distance measurements, relevant uncertainties, propa-gation of light in atmosphere); Reference sys-tem of height; Camera basics (Pinhole modes, mapping points); Relative orientation of the image pair and fun-damental matrix; Feature extraction & matching
· Profile Geodetic Earth System Science and Data Analysis: Fundamental spaces of matrices; Vector space and orthogonal projectors; Generalized solution of rank deficient systems; Generalized inverses; Spectral anal-ysis of linear systems (eigenvalues und singular values); Matrix algebra and decomposition techniques (Schur-Form, Sherman-Morrison-Formula); Sequential Adjustment; Kalman-Filter; Deterministic vs. Stochastic approx-imation; Interpolation with polynoms, splines, and finite elements in 1D and 2D; Array-Algebra; Numerics of linear equations; Multivariate probability distributions (marginal and conditional distributions); Characteristics of the electro-magnetic spectrum in the neutral and charged atmosphere; conversions of frequencies and wavelengths; Relationships between frequency, cycle frequency, phase, and arc length; Background of Dop-pler-effect; Universal law of gravitation, mass, density, and gravity; Kepler's laws, planetary and satellite mo-tion; Motion w.r.t. inertial and non-inertial reference systems; Rotation of rigid bodies; Tides
·P rofile Geoinformation and Spatial Development: Principles and framework of regional and urban planning; Strategies of rural development; Framework of land management and land tenure; Mechanism of land mar-kets, interrelation of planning and property value; Design and analysis of algorithms (e.g., incremental algo-rithms, divide and conquer, dynamic programming, greedy algorithms, geometric algorithms, graph-theoretic algorithms); Fundamental data structures (e.g., arrays, lists, binary search trees, heaps, hash tables); Object oriented modeling and programming, profound knowledge of at least one programming language; Relational databases and object-relational spatial databases; Foundations of geo-information systems (GIS), including GIS standards (e.g., the OGC simple feature specification) and data formats (e.g., GML); Cartographic visuali-zation

Qualification goals:
Additional learning objectives regarding the chosen profile, according to the students competences

2 Teaching and learning methods

#	Type	Topic	Lan-guage	Group-size	SWS	Work-load	Term
1	Guided self-study	Profile Fundamentals	en	7	2	90	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	General mandatory selec-tion	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):
The credit points are awarded for completed exercise tasks.

6 Credits according ECTS

3 LP

7	**Workload**
	90 h
8	**Duration**
	1 semester
9	**Frequency**
	winter term
10	**Maximum number of students**
	no limitation
11	**Module coordination**
	Lecturer:

Name	Organisation	SWS	exe.	res.
lecturers of the Master's Program Geodetic Engineering	Institut für Geodäsie und Geoinformation	2	X	X

Module coordinator / Organisation:
Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12	**Further information**
	none
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	22.10.2019

UNIVERSITÄT BONN

landwirtschaftliche fakultät

module manual

master's program
Geodetic Engineering
(M.Sc. GE)

Profilgebundener Pflicht- und Wahlpflichtbereich /
profile-related mandatory and elective selection
„Mobile Sensing and Robotics“

Code: **MSR-01**
Title: **Sensors and State Estimation**

1 Content and intended learning outcomes

Content:
Sensors (inertial sensors, accelerometer, gyroscope, IMU, magnetometer, laser scanner, GPS, RTK GPS); Odometry; Geometric and probabilistic motion models; Inertial navigation; Basic probabilistic models of range sensors; Environment models; Recursive Bayes filter, Kalman filter, and extended Kalman filter; Particle filter, Monte-Carlo localization; Smoothing

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in state estimation, smoothing, and filtering with a key focus on trajectory as well as pose estimation; Specialized conceptual skills to be able to solve strategic problems in the field of mobile sensing and robotics.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Sensors and State Estimation	en	20	3	90	W
2	Exercise, practical	Sensors and State Estimation	en	20	2	90	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Mobile Sensing and Robotics'	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.rer.nat. Cyrill Stachniss	Institut für Geodäsie und Geoinformation	1	X	X
Nived Chebrolu M.Sc.	Institut für Geodäsie und Geoinformation	1	X	
Prof. Dr.-Ing. Heiner Kuhlmann	Institut für Geodäsie und Geoinformation	1	X	X
Dr.rer.nat. Lasse Klingbeil	Institut für Geodäsie und Geoinformation	1	X	
Tomislav Medic M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.rer.nat. C. Stachniss, Prof. Dr.-Ing. H. Kuhlmann (Institut für Geodäsie und Geoinformation)

12 **Further information**

Thrun, Burgard, Fox: Probabilistic Robotics, MIT Press, 2005
Paul D. Groves (2007): Principles of GNSS, Inertial and multisensor navigation systems. Artech House Publishers, ISBN 1580532551, ISBN 13: 9781580532556

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **MSR-02**
Title: **Advanced Techniques for Mobile Sensing and Robotics**

1 Content and intended learning outcomes

Content:
Camera models; Sensor calibration; System calibration; Relative orientation; Simultaneous localization and mapping; Bundle adjustment; Advanced sensor modeling; Time series analysis; Correlation; Shaping filter; Advanced Kalman filters; 3D environment models; Point clouds; Visual features; Feature matching; RANSAC; Path planning

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in key methods for state estimation, smoothing, and filtering with a key focus on trajectory estimation and mapping as well as motion planning; Specialized conceptual skills to solve problems in mobile sensing and robotics

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Advanced Techniques for Mobile Sensing and Robotics	en	10	3	90	S
2	Exercise, practical	Advanced Techniques for Mobile Sensing and Robotics	en	10	2	90	S

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Mobile Sensing and Robotics'	2nd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.rer.nat. Cyrill Stachniss	Institut für Geodäsie und Geoinformation	1	X	X
Nived Chebrolu M.Sc.	Institut für Geodäsie und Geoinformation	1	X	
Prof. Dr.-Ing. Heiner Kuhlmann	Institut für Geodäsie und Geoinformation	1	X	X
Dr.rer.nat. Lasse Klingbeil	Institut für Geodäsie und Geoinformation	1	X	
Tomislav Medic M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.rer.nat. C. Stachniss, Prof. Dr.-Ing. H. Kuhlmann (Institut für Geodäsie und Geoinformation)

12 **Further information**

Thrun, Burgard, Fox: Probabilistic Robotics, MIT Press, 2005
Paul D. Groves (2007): Principles of GNSS, Inertial and multisensor navigation systems. Artech House Publishers, ISBN 1580532551, ISBN 13: 9781580532556

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **MSR-P-S**
Title: **Mobile Sensing and Robotics (MSR) - Project Part I**

1 Content and intended learning outcomes

Content:
Moving objects; Pose estimation and localization; Trajectory estimation; Simultaneous localization and mapping; Sensor calibration; Sensor fusion; Advanced sensor data interpretation; Pointcloud processing; Machine learning for perception; AI techniques for robot navigation

Qualification goals:
Ability to systematically solve relevant problems in the context of mobile sensing and robotics, document the progress and present results in a scientific way.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Mobile Sensing and Robotics (MSR) - Project Part I	en/de	15	1	60	S
2	Project	Mobile Sensing and Robotics (MSR) - Project Part I	en/de	15	5	180	S
3	Projectseminar	Mobile Sensing and Robotics (MSR) - Project Part I	en/de	15	2	120	S

3 Prerequisites to take part the module

obligatory:
4 modules from the mandatory selection, must include Profile Fundamentals (MGE-06)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Mobile Sensing and Robotics'	2nd semester
Geodäsie und Geoinformation (M.Sc.)	Pflichtbereich: Fachgebundenes Projekt	2. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Projectwork	written and/or verbal academic performance	-	graded	en/de	100 %

6 Credits according ECTS

12 LP

7 Workload

360 h

8 Duration

1 semester

9 Frequency

summer term

10 Maximum number of students

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.rer.nat. Cyrill Stachniss	Institut für Geodäsie und Geoinformation	1	X	X
Prof. Dr.-Ing. Heiner Kuhlmann	Institut für Geodäsie und Geoinformation	1	X	X
Lorenzo Nardi M.Sc.	Institut für Geodäsie und Geoinformation	3	X	
Dr.rer.nat. Lasse Klingbeil	Institut für Geodäsie und Geoinformation	3	X	

Module coordinator / Organisation:
Prof. Dr.rer.nat. C. Stachniss, Prof. Dr.-Ing. H. Kuhlmann (Institut für Geodäsie und Geoinformation)

12 **Further information**

none

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

03.12.2019

Code: **MSR-P-W**
Title: **Mobile Sensing and Robotics (MSR) - Project Part II**

1 Content and intended learning outcomes

Content:
Moving objects; Pose estimation and localization; Trajectory estimation; Simultaneous localization and mapping; Sensor calibration; Sensor fusion; Advanced sensor data interpretation; Pointcloud processing; Machine learning for perception; AI techniques for robot navigation

Qualification goals:
Ability to systematically solve relevant problems in the context of mobile sensing and robotics, document the progress and present results in a scientific way.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Mobile Sensing and Robotics (MSR) - Project Part II	en/de	15	1	60	W
2	Project	Mobile Sensing and Robotics (MSR) - Project Part II	en/de	15	5	180	W
3	Projectseminar	Mobile Sensing and Robotics (MSR) - Project Part II	en/de	15	2	120	W

3 Prerequisites to take part the module

obligatory:
Mobile Sensing and Robotics (MSR) - Project Part I (MSR-P-S)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Mobile Sensing and Robotics'	3rd semester
Geodäsie und Geoinformation (M.Sc.)	Pflichtbereich: Fachgebundenes Projekt	3. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Projectwork	written and/or verbal academic performance	-	graded	en/de	50 %
Written report	written and/or verbal academic performance	-	graded	en/de	50 %

6 Credits according ECTS

12 LP

7 Workload

360 h

8 Duration

1 semester

9 Frequency

winter term

10	**Maximum number of students**
	no limitation
11	**Module coordination**
	Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.rer.nat. Cyrill Stachniss	Institut für Geodäsie und Geoinformation	1	X	X
Prof. Dr.-Ing. Heiner Kuhlmann	Institut für Geodäsie und Geoinformation	1	X	X
Lorenzo Nardi M.Sc.	Institut für Geodäsie und Geoinformation	3	X	
Dr.rer.nat. Lasse Klingbeil	Institut für Geodäsie und Geoinformation	3	X	

	Module coordinator / Organisation: Prof. Dr.rer.nat. C. Stachniss, Prof. Dr.-Ing. Heiner Kuhlmann (Institut für Geodäsie und Geoinformation)
12	**Further information**
	none
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	03.12.2019

Code: **MSR-03-MCCV**
Title: **Modern C++ for Computer Vision**

1 Content and intended learning outcomes

Content:
Programming in C++; Revision control using git; Solving typical image processing task using C++ and OpenCV; Feature extraction; Clustering; Segmentation; Matching

Qualification goals:
Detailed comprehensive knowledge in programming in C++ with focus on image processing; Specialized conceptual skills to solve typical image processing tasks using C++ and OpenCV such as feature extraction, clustering, segmentation, and matching; Use of revision control systems such as git

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Modern C++ for Computer Vision	en	20	1	45	S
2	Exercise, scientific/practical	Modern C++ for Computer Vision	en	20	2	75	S
3	Seminar	Modern C++ for Computer Vision	en	20	1	60	S

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile ‘Mobile Sensing and Robotics’	2nd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	2. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.rer.nat. Cyrill Stachniss	Institut für Geodäsie und Geoinformation	1	X	X
Ignacio Vizzo M.E.E.	Institut für Geodäsie und Geoinformation	3	X	

Module coordinator / Organisation:
Prof. Dr.rer.nat. C. Stachniss (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
http://docs.opencv.org/2.4/doc/tutorials/tutorials.html
https://www.atlassian.com/git/tutorials

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

03.12.2019

Code: **MSR-04-GNSS**
Title: **GNSS - Methods for Quality Assurance**

1 Content and intended learning outcomes

Content:
Common and state-of-the-art techniques to minimize systematic observation errors; Handling of GNSS equipment and post-processing software packages; Conception and realization of suitable field test; Interpretation of GNSS data and processing results; Implementation of standard code-based position determination

Qualification goals:
Knowledge in performing and processing GNSS-observations; In-depth knowledge of systematic observation errors in GNSS; Implementation of algorithms for the detection, quantification and minimization of systematic observation errors; Realization and analysis of test measurements

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	GNSS: Methods for Quality Assurance	en	10	1	45	W
2	Exercise, practical	GNSS: Methods for Quality Assurance	en	10	2	75	W
3	Seminar	GNSS: Methods for Quality Assurance	en	10	1	60	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
Global Navigation Satellite Systems (MGE-02)

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Mobile Sensing and Robotics'	3rd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Projektarbeit	written and/or verbal academic performance	100	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Heiner Kuhlmann	Institut für Geodäsie und Geoinformation	1	X	X
Dr.-Ing. Florian Zimmermann	Institut für Geodäsie und Geoinformation	2	X	X
Ansgar Dreier M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. H. Kuhlmann (Institut für Geodäsie und Geoinformation)

12 **Further information**

none

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

26.02.2020

Code: **MSR-05-KMMS**
Title: **Application and Evaluation of Kinematic Mobile-Sensor-Systems**

1 Content and intended learning outcomes

Content:
Planning and performing measurement campaigns with kinematic sensor system setups in urban or agricultural environments. Data processing of raw data (Inertial sensors, GNSS, laser scanner, cameras) to generate georeferenced point clouds or other 3D information. Point cloud processing and data interpretation. Quality assessment of the final or intermediate results

Qualification goals:
Planning of measurement campaigns. Performing measurements using various geodetic measurement methods (GNSS, TLS, mobile mapping). Interpretation, evaluation and presentation of the results

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Workload	Term
1	Lecture	Application and Evaluation of Kinematic Mobile-Sensor-Systems	en	10	1	45	W
2	Exercise, practical	Application and Evaluation of Kinematic Mobile-Sensor-Systems	en	10	2	75	W
3	Seminar	Application and Evaluation of Kinematic Mobile-Sensor-Systems	en	10	1	60	W

3 Prerequisites to take part the module

obligatory:
Sensors and State Estimation (MSR-01)

recommended:
Advanced Techniques for Mobile Sensing and Robotics (MSR-02)

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Mobile Sensing and Robotics'	3rd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Colloquium	written and/or verbal academic performance	20	graded	en	25 %
Written term paper	written and/or verbal academic performance	-	graded	en	75 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 **Maximum number of students**

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Heiner Kuhlmann	Institut für Geodäsie und Geoinformation	1	X	X
Dr.rer.nat. Lasse Klingbeil	Institut für Geodäsie und Geoinformation	2	X	X
Tomislav Medic M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. Heiner Kuhlmann

12 **Further information**

none

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **MSR-06-RPROS**
Title: **Robot Perception using ROS**

1 Content and intended learning outcomes

Content:
The Robot Operating System ROS; Developing ROS modules; Classification and machine learning for robot navigation; Advanced perception; Robot navigation systems

Qualification goals:
Detailed comprehensive knowledge of key methods for robot perception and navigation including the development of robot modules using C++; Programming skills in C++ that enable the implementation of the techniques discussed in the course; Use of revision control systems such as git

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Robot Perception using ROS	en	20	1	45	W
2	Exercise, practical	Robot Perception using ROS	en	20	2	75	W
3	Seminar	Robot Perception using ROS	en	20	1	60	W

3 Prerequisites to take part the module

obligatory:
Sensors and State Estimation (MSR-01), Modern C++ for Image Processing (MSR-03-MCCV)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile ‘Mobile Sensing and Robotics’	3rd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	3. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.rer.nat. Cyrill Stachniss	Institut für Geodäsie und Geoinformation	1	X	X
Andres Milioto M.E.E.	Institut für Geodäsie und Geoinformation	3	X	

Module coordinator / Organisation:
Prof. Dr.rer.nat. C. Stachniss (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
http://wiki.ros.org/ROS/Tutorials

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **MSR-07-PCPC**
Title: **Point Cloud Processing**

1 Content and intended learning outcomes

Content:
Handling of Laserscanner equipment and processing software packages; Interpretation of Point-Cloud data, point cloud processing algorithms, and processing results (e.g registration, resampling, color/normal vectors/scalar fields management, statistics computation, sensor management, interactive or automatic segmentation, etc.)

Qualification goals:
Knowledge in performing and processing Point-Clouds

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Point Cloud Processing	en	10	1	45	W
2	Exercise, practical	Point Cloud Processing	en	10	2	75	W
3	Seminar	Point Cloud Processing	en	10	1	60	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Mobile Sensing and Robotics'	3rd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Projectwork	written and/or verbal academic performance	-	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Dr.rer.nat. Lasse Klingbeil	Institut für Geodäsie und Geoinformation	1	X	X
Dr.-Ing. Christoph Holst	Institut für Geodäsie und Geoinformation	1	X	X
Berit Schmitz M.Sc.	Institut für Geodäsie und Geoinformation	1	X	
Jannik Janßen M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. H. Kuhlmann (Institut für Geodäsie und Geoinformation)

12 **Further information**

none

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

28.02.2020

UNIVERSITÄT BONN

landwirtschaftliche fakultät

module manual

master's program
Geodetic Engineering
(M.Sc. GE)

Profilgebundener Pflicht- und Wahlpflichtbereich /
profile-related mandatory and elective selection
„Geodetic Earth System Science and Data Analysis“

Code: **GES-01**
Title: **Satellite Geodesy and Earth System**

1 Content and intended learning outcomes

Content:
Introduction to geometric space-geodetic techniques (SLR, GNSS, VLBI, DORIS , radar altimetry, intersatellite ranging); Earth in space; Dynamical satellite geodesy; Spherical harmonics and spherical harmonic computations; Force model; Gravity field representation; Space gravimetry; Effects of mass transports on geodetic observables (solid Earth, atmosphere, ocean, hydrosphere); Rotation of a rigid body and a deforming Earth; Geophysical fluid effects on polar motion and changes in length-of-day

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in satellite and space geodesy. Specialized conceptual skills to be able to apply the most relevant satellite techniques for specific fields of Earth system research.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Satellite Geodesy and Earth System	en	20	3	90	W
2	Exercise, scientific	Satellite Geodesy and Earth System	en	20	1	45	W
3	Exercise, practical	Satellite Geodesy and Earth System	en	20	1	45	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Geodetic Earth System Science and Data Analysis'	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jürgen Kusche	Institut für Geodäsie und Geoinformation	1	X	X
PD Dr.-Ing. Luciana Fenoglio-Marc	Institut für Geodäsie und Geoinformation	2	X	X
Jun. Prof. Dr.techn. Michael Schindelegger	Institut für Geodäsie und Geoinformation	2	X	X

Module coordinator / Organisation:
Prof. Dr.-Ing. J. Kusche (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
Seeber, G. (2008): Satellite Geodesy. Foundations, Methods, and Applications. Berlin, Boston: De Gruyter
Heiskanen and Moritz (1967): Physial Geodesy. https://archive.org/details/heiskanen_morits_1967_physical_geodesy
Torge, W. & Müller, J. (2012). Geodesy, 4th edition. Berlin, Boston: DeGruyter.

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **GES-02**
Title: **Advanced Data Analysis**

1 Content and intended learning outcomes

Content:
Fundamental of potential theory, boundary value problems, physical geodesy, geoid determination; Basic concepts of geostatistics, deterministic approximation (polynoms, finite elements, splines), stochastic approximation (stochastic processes, stationary, covariance functions, Wiener-Kolmogorov-filtering, kriging, collocation)

Qualification goals:
Acquisition of detailed comprehensive knowledge of state-of-the-art in physical geodesy and geostatistics with a special focus on a variety of deterministic and stochastic approaches; Specialized conceptual skills to be able to apply the most relevant data analysis methods to problems of physical geodesy. After successful completion of the course, the students have acquired basic skills to approximate spatial data and are able to assess the pros and cons of the different strategies. They are able to apply geostatistical concepts to practical applications.

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Advanced Data Analysis	en	10	3	90	S
2	Exercise, scientific	Advanced Data Analysis	en	10	2	90	S

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Geodetic Earth System Science and Data Analysis'	2nd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.techn. Wolf-Dieter Schuh	Institut für Geodäsie und Geoinformation	1	X	X
Till Schubert M.Sc.	Institut für Geodäsie und Geoinformation	1.5	X	
Prof. Dr.-Ing. Jürgen Kusche	Institut für Geodäsie und Geoinformation	1	X	X
Dr.-Ing. Makan Karegar	Institut für Geodäsie und Geoinformation	1.5	X	

Module coordinator / Organisation:
Prof. Dr.techn. W.-D. Schuh (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
Koch, K.R. (1999): Parameter Estimation and Hypothesis Testing in Linear Models. Springer
Gilbert Strang, Kai Borre(1997): Linear Algebra, Geodesy, and GPS. Wellesley-Cambridge Press, ISBN 0-9614088-6-3

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **GES-1-P-S**
Title: **Geodetic Earth System Science and Data Analysis (GES) - Project Part I**

1 Content and intended learning outcomes

Content:
Extension of the existing MATLAB toolbox "Space Geodesy Simulator Bonn" including simulations of measurement processes in space-geodetic observing techniques such as SLR, VLBI, GPS, altimetry, and gravity missions; Simulation of perturbing effects, Earth rotation and transformations; Methods of processing satellite data, observing models, simulations of data analysis processes, and planning of new satellite missions or observing stations; Extension of the toolbox's module handbook

Qualification goals:
Ability to work in a team on a complex and demanding scientific challenge in the field of space geodesy applying contemporary research methods; Capability to document and present the work and results in a concise manner to the scientific community; Understanding scientific literature; Understanding and exploration of interdisciplinary contents

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Geodetic Earth System Science and Data Analysis (GES) - Project Part I	en/de	15	1	60	S
2	Project	Geodetic Earth System Science and Data Analysis (GES) - Project Part I	en/de	15	5	180	S
3	Projectseminar	Geodetic Earth System Science and Data Analysis (GES) - Project Part I	en/de	15	2	120	S

3 Prerequisites to take part the module

obligatory:
4 modules from the mandatory selection, must include Profile Fundamentals (MGE-06)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Mobile Sensing and Robotics'	2nd semester
Geodäsie und Geoinformation (M.Sc.)	Pflichtbereich: Fachgebundenes Projekt	2. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Projectwork	written and/or verbal academic performance	-	graded	en/de	100 %

6 Credits according ECTS

12 LP

7 Workload

360 h

8	**Duration**
	1 semester
9	**Frequency**
	summer term
10	**Maximum number of students**
	no limitation
11	**Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jürgen Kusche	Institut für Geodäsie und Geoinformation	2	X	X
Prof. Dr. techn. Wolf-Dieter Schuh	Institut für Geodäsie und Geoinformation	2	X	X
Jun. Prof. Dr.-Ing. Ribana Roscher	Institut für Geodäsie und Geoinformation	2	X	X
PD Dr.-Ing. Luciana Fenoglio-Marc	Institut für Geodäsie und Geoinformation	1	X	
Bernd Uebbing MS.c.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J. Kusche (Institut für Geodäsie und Geoinformation)

12	**Further information**
	none
13	**Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14	**Date of version**
	03.12.2019

Code: **GES-1-P-W**
Title: **Geodetic Earth System Science and Data Analysis (GES) - Project Part II**

1 Content and intended learning outcomes

Content:
Extension of the existing MATLAB toolbox "Space Geodesy Simulator Bonn" including simulations of measurement processes in space-geodetic observing techniques such as SLR, VLBI, GPS, altimetry, and gravity missions; Simulation of perturbing effects, Earth rotation and transformations; Methods of processing satellite data, observing models, simulations of data analysis processes, and planning of new satellite missions or observing stations; Extension of the toolbox's module handbook

Qualification goals:
Ability to work in a team on a complex and demanding scientific challenge in the field of space geodesy applying contemporary research methods; Capability to document and present the work and results in a concise manner to the scientific community; Understanding scientific literature; Understanding and exploration of interdisciplinary contents

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Geodetic Earth System Science and Data Analysis (GES) - Project Part II	en/de	15	1	60	W
2	Project	Geodetic Earth System Science and Data Analysis (GES) - Project Part II	en/de	15	5	180	W
3	Projectseminar	Geodetic Earth System Science and Data Analysis (GES) - Project Part II	en/de	15	2	120	W

3 Prerequisites to take part the module

obligatory:
Geodetic Earth System Science and Data Analysis (GES) - Project Part I (GES-1-P-S)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Geodetic Earth System Science and Data Analysis'	3rd semester
Geodäsie und Geoinformation (M.Sc.)	Pflichtbereich: Fachgebundenes Projekt	3. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Projectwork	written and/or verbal academic performance	-	graded	en/de	50 %
Written report	written and/or verbal academic performance	-	graded	en/de	50 %

6 Credits according ECTS

12 LP

7	**Workload** 360 h
8	**Duration** 1 semester
9	**Frequency** winter term
10	**Maximum number of students** no limitation
11	**Module coordination** Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jürgen Kusche	Institut für Geodäsie und Geoinformation	2	X	X
Prof. Dr. techn. Wolf-Dieter Schuh	Institut für Geodäsie und Geoinformation	2	X	X
Jun. Prof. Dr.-Ing. Ribana Roscher	Institut für Geodäsie und Geoinformation	2	X	X
PD Dr.-Ing. Luciana Fenoglio-Marc	Institut für Geodäsie und Geoinformation	1	X	
Bernd Uebbing MS.c.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.techn. W.-D. Schuh (Institut für Geodäsie und Geoinformation)

12	**Further information** none
13	**Additional information for internal use / planning only** Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version** 03.12.2019

Code: **GES-03-MTMM**
Title: **Mass Transport Modellig and Monitoring**

1 Content and intended learning outcomes

Content:
Principles of physical oceanography, Navier-Stokes and geostrophic equations, ocean currents, boundary layer; Fundamentals of Earth's climate and radiation budget; Topics in hydrology, hydrological cycle, hydrological observation and modelling, glacial cycles, loading, and viscoelastic Earth models, Principles that govern sea level, the sea-level equation; Interpretation of time-variable gravity and of sea level changes; Analysis of data products, data assimilation, sampling properties of satellite orbits; Design of satellite missions

Qualification goals:
Fundamental knowledge of dynamical processes in the ocean, terrestrial hydrosphere and solid Earth and their representation through numerical means; Competence in applying forward modeling techniques for Earth system research; Scientific programming skills; Understanding advanced scientific publications; Discussion of scientific methods; Ability to transfer knowledge of Earth system processes related scientific challenges, such as the design of a satellite mission

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Mass Transport Modellig and Monitoring	en	20	3	90	S
2	Exercise, practical	Mass Transport Modellig and Monitoring	en	20	2	90	S

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geodetic Earth System Science and Data Analysis'	2nd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	2. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10 **Maximum number of students**

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jürgen Kusche	Institut für Geodäsie und Geoinformation	3	X	X
Dr.-Ing. Makan Karegar	Institut für Geodäsie und Geoinformation	2	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J. Kusche (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
ESA, Radar Altimetry Tutorial. http://www.altimetry.info/radar-altimetry-tutorial/
Ilk et al.(2005): Mass Transport and Mass Distribution in the Earth System. Www.iapg.bgu.tum.de/medi-adb/21768/21769/programmschrift-Ed2.pdf

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

03.12.2019

Code: **GES-04-NCPP**
Title: **Numerics in C++**

1 Content and intended learning outcomes

Content:
Working in a LINUX environment; C++ basics (data types, loops, conditional statements, integral and floating point numbers, arrays and pointers, memory management, functions); Templates and standard library; Object orientated programming, classes in C++ (operators); I/O; Compiling and linking programs (libraries, preprocessor, compiler and linker, make/cmake); Program optimization; Modern features of C++; Standard libraries for linear algebra (Basic Linear Algebra Subprograms and Linear Algebra Package); Introduction to parallel computing, concepts of parallel architectures, introduction to the message passing interface (basic idea and features, point to point and collective communication, parallel adjustment procedure)

Qualification goals:
Specialized conceptual skills for scientific programming in C++, mapping of numerical algorithms to the object oriented C++ programming language, and the use of scientific standard libraries for linear algebra (BLAS, LAPACK); Expert knowledge in parallel programming and software development for the implementation of massive parallel numerical software with applications to adjustment problems

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Numerics in C++	en	10	3	120	S
2	Exercise, scientific/practical	Numerics in C++	en	10	0	60	S
3	Tutorial	Numerics in C++	en	10	1	0	S

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geodetic Earth System Science and Data Analysis'	2nd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Assignments	none	-	graded	en	50 %
Oral examination	passed assignments (PE1)	25	graded	en	50 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10	**Maximum number of students**
	no limitation
11	**Module coordination**
	Lecturer:

Name	Organisation	SWS	exe.	res.
Dr.-Ing. Jan Martin Brockmann	Institut für Geodäsie und Geoinformation	3	X	X

Module coordinator / Organisation:
Dr.-Ing. J.M. Brockmann, Prof. Dr.techn. W.-D. Schuh (Institut für Geodäsie und Geoinformation)

12	**Further information**
	References: Gropp, W.; Lusk, E. & Skjellum, A. Kowalik, J. (Ed.) Using MPI - Portable Parallel Programming with the Mes-sage-Passing Interface MIT Press, 1999 Gropp, W.; Lusk, E. & Thakur, R. Kowalik, J. (Ed.) Using MPI-2 Advanced features of the Message-Passing In-ter-face MIT Press, 1999 Karniadakis, G. E. & Kirby, R. M. Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Paral-lel Algorithms and their Implementation Cambridge University Press, 2003 MPI Forum. MPI: A Message-Passing Interface Standard Rauber, T. & Rünger, G. Parallel Programming for Multicore and Cluster Systems Springer, 2013 Stroustrup, B. The C++ Programming Language. Fourth edition. Addison-Wesley, 2013.
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: 1 tutor for tutorial, 7.5 h/week, 6 months (id zu M46-NCPP) Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	03.12.2019

Code: **GES-05-MWCC**

Title: **Monitoring Water and Cryospheric Change from Space**

1 Content and intended learning outcomes

Content:

Satellite Altimetry: Monitoring of water level change from radar measurements from space; conventional, delay Doppler, wide-swath radar altimetry and near-nadir interferometry concepts; applications to geodesy, oceanography, hydrology and geophysics; multi-sensors space and in-situ data combination, data analysis and data reconstruction; interpretation in the context of climate change, long-term changes and extreme events, sea level prediction

Ice Sheet Signals: Introduction to the physical workings of ice sheets, their importance for climate, sea level, and their connection to atmospheric and oceanic variability; ice sheet dynamics and instabilities; determination of mass balances (input/output method, use of satellite techniques); solid-Earth feedbacks; present and future evolution of the Greenland and Antarctic Ice Sheets; discussion of topical research questions based on scientific journal articles

Qualification goals:

Satellite altimetry: Understand lecture content and lecture material; get familiar with new methods and data by solving exercise in group and alone; be able to apply methodology to other cases; read, understand and summarize articles in scientific journals; develop ability of critical discussion of written and presented topics

Ice Sheet Signals: Understanding lecture contents and applying individual concepts (e.g., mass balance determination from satellite gravimetry) to specific questions at hand; analysis of scientific journal articles with particular emphasis on evaluating methods involved; summarizing, illustrating, and deriving scientific results and assessing them in terms of their credibility, relevance and implication

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Satellite Altimetry - Monitoring Water and Cryospheric Change from Space	en	15	2	60	W
2	Exercise, scientific	Satellite Altimetry - Monitoring Water and Cryospheric Change from Space	en	15	1	30	W
3	Lecture	Ice Sheet Signals - Physics and Space Geodetic Observation	en	15	1	30	W
4	Seminar	Ice Sheet Signals - Physics and Space Geodetic Observation	en	15	1	60	W

3 Prerequisites to take part the module

obligatory:

none

recommended:

Satellite Geodesy and Earth System (GES-01)

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geodetic Earth System Science and Data Analysis'	3rd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Dura-tion	graded/ not graded	Lan-guage	Weight
Oral examination	written and/or verbal academic performance (Satellite Altimetry)	20	graded	en	60 %
Oral presentation	none (Ice Sheet Signals)	15	graded	en	40 %

6 **Credits according ECTS**

6 LP

7 **Workload**

180 h

8 **Duration**

1 semester

9 **Frequency**

winter term

10 **Maximum number of students**

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
PD Dr.-Ing. Luciana Fenoglio-Marc	Institut für Geodäsie und Geoinformation	3	X	X
Jun. Prof. Dr.techn. Michael Schindeleg-ger	Institut für Geodäsie und Geoinformation	2	X	X

Module coordinator / Organisation:
Dr.-Ing. L. Fenoglio-Marc, Jun. Prof. Dr. techn. M. Schindelegger (Institut für Geodäsie und Geoinformation)

12 **Further information**

The part 'Ice Sheet Signals' is also teached in program 'Geodäsie und Geoinformation (M.Sc.) - Fachgebunde-ner Wahlpflichtbereich: Wahlpflichtmodul "klein"'

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

03.12.2019

Code: **GES-06-SPR**
Title: **Stochastic Processes**

1 Content and intended learning outcomes

Content:

Deterministic signal processing for periodic and non periodic, continuous time series (amplitude and phase spectrum, Parseval theorem, Fourier transform, convolution) Transition from continuous to discrete time series (Dirac Delta distribution, sampling theorem, window-function, discrete Fourier transform, discrete cyclic and linear convolution); discrete digital filters (design in time domain and frequency domain).

The problem of data interpolation and prediction. Revision of the least-squares principle and Tikhonov regularization. The collocation approach and its deterministic and stochastic interpretation. Wiener-Kolmogorov optimization principle. Collocation estimates and error estimates with and without change of functional. Empirical covariance estimation and the concepts of invariance by translations and rotations. Examples of covariance models. Wiener filter and power spectra in the frequency domain. The generalization to the least-squares collocation approach and to the ordinary kriging.

The collocation approach is applied to a set of numerical examples, and in particular to the data filtering and prediction of a 1D time series, to an inverse gravimetric problem in 2D planar approximation and to a geoid determination from gravity data in spherical approximation. These examples are performed in a computer laboratory, preferably by using MATLAB software.

Keywords: Interpolation Theory · Collocation · Least Squares Collocation · Wiener Filter · Empirical Covariance Estimation · Covariance Models · Example of 1D Time Series Filtering · Example of 2D Inverse Gravimetric Problem · Example of Gravimetric Geoid Determination · MATLAB Software Development

Qualification goals:

Acquisition of expert knowledge on data analysis of deterministic and stochastic signals processing; Ability to apply the most relevant techniques to analyse and transform deterministic and stochastic signals; Ability to collect, describe, evaluate, and to interpret scientific information and to draw scientifically founded conclusions; Ability of recognition and application of complex topical relationships; Competences in transfer of knowledge to other techniques

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Stochastic Processes	en	10	2	45	W
2	Exercise, practical	Stochastic Processes	en	10	1	45	W
3	Lecture	Collocation and Applications	en	10	1	60	W
4	Exercise, scientific/practical	Collocation and Applications	en	10	1	30	W

3 Prerequisites to take part the module

obligatory:

positive final exam of the module "Statistics and Adjustment Theory (MGE-03)"

recommended:

positive conclusion of the module "Advanced Data Analysis (GES-02)", very good knowledge of OCTAVE/MATLAB

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geodetic Earth System Science and Data Analysis'	3rd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance (Stochastic Processes)	25	graded	en	50 %
Assignments	none (Collocation and Applications)	·	graded	en	50 %

6 **Credits according ECTS**

6 LP

7 **Workload**

180 h

8 **Duration**

1 semester

9 **Frequency**

winter term

10 **Maximum number of students**

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.techn. Wolf-Dieter Schuh	Institut für Geodäsie und Geoinformation	1	X	X
Dr.-Ing. Jan Martin Brockmann	Institut für Geodäsie und Geoinformation	1	X	
Till Schubert M.Sc.	Institut für Geodäsie und Geoinformation	1	X	
Dr. Mirko Reguzzoni	Lehrbeauftragter (Politecnico di Milano)	2	X	X

Module coordinator / Organisation:
Prof. Dr.techn. W.-D. Schuh (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:

Buttkus, Burkhard (2000): Spectral Analysis and Filter Theory in Applied Geophysics. Berlin; New York: Springer

Brockwell, Peter J., and Richard A. Davis (2006): Time Series: Theory and Methods. 2. ed., Reprint of the 1991 ed. Springer Series in Statistics. New York, NY: Springer

Hamming, W. (1998): Digital Filters. 3.ed., Dover Publications

Moritz, H. (1980): Advanced Physical Geodesy. Wichmann.

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **GES-07-SATGEO**
Title: **Advanced Methods in Satellite Geodesy**

1 Content and intended learning outcomes

Content:
Special methods in satellite geodesy (tracking, intersatellite ranging, gradiometry); Principles and data processing of in pulse-limited and delay-Doppler radar altimetry; Special methods of orbit integration, complete force model for near-Earth satellites, non-conservative force modelling, precise orbit determination; Fundamental of relativistic modelling, relativistic effects in satellite geodesy

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in satellite-geodetic modelling and data processing; Ability to collect, describe, evaluate, and to interpret scientific information and to draw scientifically founded conclusions; Ability of recognition and application of complex topical relationships, competences in transfer of knowledge to other techniques

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Advanced Methods in Satellite Geodesy	en	20	3	90	W
2	Exercise, practical	Advanced Methods in Satellite Geodesy	en	20	2	90	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geodetic Earth System Science and Data Analysis'	3rd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	3. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10	**Maximum number of students**
	no limitation
11	**Module coordination**
	Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jürgen Kusche	Institut für Geodäsie und Geoinformation	2	X	X
PD Dr.-Ing. Luciana Fenoglio-Marc	Institut für Geodäsie und Geoinformation	2	X	
Dr.-Ing. Roloef Rietbroek	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J. Kusche (Institut für Geodäsie und Geoinformation)

12	**Further information**
	References: ESA, Radar Altimetry Tutorial. Www.altimetry.info/radar-altimetry-tutorial/ Remko Scharroo (2002): A Decade of ERS Satellite Orbits and Altimetry. Majid Naeimi and Jakob Flury (Eds.) (2017): Global Gravity Field Modeling from Satellite-to-Satellite Tracking Data. Springer Lecture Notes in Earth System Sciences
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	29.11.2019

UNIVERSITÄT BONN

landwirtschaftliche fakultät

module manual

master's program
Geodetic Engineering
(M.Sc. GE)

Profilgebundener Pflicht- und Wahlpflichtbereich /
profile-related mandatory and elective selection
„Geoinformation and Spatial Development“

Code: **GSD-01**
Title: **Urban Development**

1 Content and intended learning outcomes

Content:
Current determinants and trends in urban development: reurbanization, suburbanization, urban sprawl, demographic change, climate change, energy demand; Models and principles for sustainable urban development and a resiliency city; Quantitative and qualitative methods of planning (MCA, UVP); Strategies and instruments of sustainable and resilient urban development: cost, land and resource efficiency, climate adaptation; Social housing, participation models; Planning and land management approaches to internal development: gap between buildings, redensification, brownfield redevelopment; Cooperative and sovereign action; Strategies and legal instruments of city renewal: urban regeneration, social urban renewal and urban reconstruction, urban design and urban preservation; Urban monument protection

Qualification goals:
Ability to collect, describe, evaluate, and to interpret scientific information and to draw scientifically founded conclusions; Ability of recognition and application of complex topical relationships; Detailed comprehensive knowledge of state-of-the-art in urban development; Specialized conceptual skills to to solve strategic problems in urban development

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Urban Development	en	10	3	90	W
2	Exercise, scientific	Urban Development	en	10	2	90	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Geoinformation and Spatial Development'	1st semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Theo Kötter	Institut für Geodäsie und Geoinformation	3	X	X
Dr.-Ing. Asad Asadzadeh	Institut für Geodäsie und Geoinformation	1	X	
Mahsa Moghadas M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:
Hopkins, L.D. (2001): Urban Development: The Logic Of Making Plans, ISBN 1-55963-852-4
Brunn, St. D., Hays-Mitchell, M., Zeigler, D.J. (2012): Cities of the World: World Regional Urban Development, Published by Rouman & Littlefield Education, Plymouth, UK, ISBN 978-1-4422-1284-8

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

04.12.2018

Code: **GSD-02**
Title: **Spatial Decision Support Systems**

1 Content and intended learning outcomes

Content:

Methods of operations research in spatial planning; Spatial unit allocation; Districting; Facility location; Mathematical modelling; Mathematical programming; Linear and integer linear programming; Neighborhood analysis; Applications of neighborhood graphs, Voronoi diagrams, and triangulations in planning, Theories of decision making in spatial planning; cost-benefit-analysis; dynamic urban calculation; scenario planning; multiple criteria assessment methods; risk, vulnerability and resilience assessment, site assessment, SWOT-analysis, optimization of land use planning

Qualification goals:

Detailed comprehensive competences in abstracting problems of spatial planning in mathematical terms; Specialized conceptual skills to solve problems with optimization software; Scientific writing with terminology of spatial decision support systems, Use of geo-data as well as free and commercial software

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Spatial Decision Support Systems	en	20	3	90	S
2	Exercise, practical	Spatial Decision Support Systems	en	20	2	90	S

3 Prerequisites to take part the module

obligatory:

none

recommended:

none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Geoinformation and Spatial Development'	2nd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	2. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10 **Maximum number of students**

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	2	X	X
Prof. Dr.-Ing. Theo Kötter	Institut für Geodäsie und Geoinformation	1	X	X
Annika Bonerath M.Sc.	Institut für Geodäsie und Geoinformation	1	X	
Johannes Oehrlein M.Sc.	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J.-H. Haunert (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:

Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (2009): Introduction to Algorithms. 3rd Edition, MIT Press. ISBN: 9780262533058

de Berg, Mark, Otfried Cheong, Marc van Kreveld, and Mark Overmars (2008): Computational Geometry – Algorithms and Applications. 3rd Edition, Springer-Verlag. ISBN:3540779736 9783540779735

Geertman, Stan; Stillwell, John (Eds.) (2009): Planning Support Systems. Best practice and new methods. [Dordrecht]: Springer (Geojournal / Library, 95).

Geertman, Stan; Allan, Andrew; Pettit, Chris; Stillwell, John (2017): Planning Support Science for Smarter Urban Futures. Verlag Springer, ISBN 3319578197, 978331957819

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **GSD-P-S**
Title: **Geoinformation and Spatial Development (GSD) - Project Part I**

1 Content and intended learning outcomes

Content:
Current topics of geoinformation and spatial development

Qualification goals:
Successful students are able to work in a group on an open research problem related to geoinformation and spatial development. They are able to define realistic project goals, to choose and apply appropriate methods and tools for accomplishing these goals, and to assess their results critically

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Geoinformation and Spatial Development (GSD) - Project Part I	en/de	15	1	60	S
2	Project	Geoinformation and Spatial Development (GSD) - Project Part I	en/de	15	5	180	S
3	Projectseminar	Geoinformation and Spatial Development (GSD) - Project Part I	en/de	15	2	120	S

3 Prerequisites to take part the module

obligatory:
4 modules from the mandatory selection, must include Profile Fundamentals (MGE-06)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Mobile Sensing and Robotics'	2nd semester
Geodäsie und Geoinformation (M.Sc.)	Pflichtbereich: Fachgebundenes Projekt	2. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Projectwork	written and/or verbal academic performance	-	graded	en/de	100 %

6 Credits according ECTS

12 LP

7 Workload

360 h

8 Duration

1 semester

9 Frequency

summer term

10 Maximum number of students

no limitation

11	**Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	2.5	X	X
Prof. Dr.-Ing. Theo Kötter	Institut für Geodäsie und Geoinformation	2.5	X	X
Anna-Maria Bolte M.Sc.	Institut für Geodäsie und Geoinformation	1.5	X	
Dr.rer.nat. Benjamin Niedermann	Institut für Geodäsie und Geoinformation	1.5	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J.-H. Haunert, Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12	**Further information**
	References depending on the project topic
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	29.11.2019

Code: **GSD-P-W**
Title: **Geoinformation and Spatial Development (GSD) - Project Part II**

1 Content and intended learning outcomes

Content:
Current topics of geoinformation and spatial development

Qualification goals:
Successful students are able to work in a group on an open research problem related to geoinformation and spatial development. They are able to define realistic project goals, to choose and apply appropriate methods and tools for accomplishing these goals, and to assess their results critically

2 Teaching and learning methods

#	Type	Topic	Lan-guage	Group-size	SWS	Work-load	Term
1	Lecture	Geoinformation and Spatial De-velopment (GSD) - Project Part II	en/de	15	1	60	W
2	Project	Geoinformation and Spatial De-velopment (GSD) - Project Part II	en/de	15	5	180	W
3	Projectseminar	Geoinformation and Spatial De-velopment (GSD) - Project Part II	en/de	15	2	120	W

3 Prerequisites to take part the module

obligatory:
Geoinformation and Spatial Development (GSD) - Project Part I (GSD-P-S)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Profile-related mandatory selection: Study profile 'Mobile Sensing and Ro-botics'	3rd semester
Geodäsie und Geoinformation (M.Sc.)	Pflichtbereich: Fachge-bundenes Projekt	3. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Dura-tion	graded/ not graded	Lan-guage	Weight
Projectwork	written and/or verbal academic performance	-	graded	en/de	50 %
Written report	written and/or verbal academic performance	-	graded	en/de	50 %

6 Credits according ECTS

12 LP

7 Workload

360 h

8 Duration

1 semester

9 Frequency

winter term

10	**Maximum number of students**
	no limitation
11	**Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	2.5	X	X
Prof. Dr.-Ing. Theo Kötter	Institut für Geodäsie und Geoinformation	2.5	X	X
Anna-Maria Bolte M.Sc.	Institut für Geodäsie und Geoinformation	1.5	X	
Dr.rer.nat. Benjamin Niedermann	Institut für Geodäsie und Geoinformation	1.5	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J.-H. Haunert, Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12	**Further information**
	References depending on the project topic
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	29.11.2019

Code: **GSD-03-LAMA**
Title: **Land Management**

1 Content and intended learning outcomes

Content:
Land policy; land tenure, land cadastre, land register; land law and land tax, land use rights and burdens on land, public and private stakeholders; instruments of private and public law for building land development and provision: land use planning, planning safeguarding, land readjustment and land reallocation, urban development measure; urban contracts, land acquisition, voluntary and sovereign land management procedures; expropriation, infrastructure provision, urban development measures; land management in urban regeneration and urban redevelopment; processes, actors, and funding urban land management projects

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in land management; specialized conceptual skills to solve strategic problems in land management; Ability to collect, describe, evaluate, and to interpret scientific information and to draw scientifically founded conclusions; Ability of recognition and application of complex topical relationships; Competence in transfer of knowledge to other challenges

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Land Management	en	10	1	45	S
2	Exercise, scientific	Land Management	en	10	2	75	S
3	Seminar	Land Management	en	10	1	60	S

3 Prerequisites to take part the module

obligatory:
Urban Development (GSD-01), Profile Fundamentals (MGE-06)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geoinformation and Spatial Development'	2nd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral presentation	written and/or verbal academic performance	20	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10 Maximum number of students

no limitation

11	**Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Theo Kötter	Institut für Geodäsie und Geoinformation	1	X	X
Mahsa Moghadas M.Sc.	Institut für Geodäsie und Geoinformation	1.5	X	
Dr.-Ing. Asad Asadzadeh	Institut für Geodäsie und Geoinformation	1.5	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12	**Further information**

References:

Gerber, J.-D.; Hartmann, Th.; Hengstermann, A. (Ed.) (2018): Instruments of Land Policy: Dealing with Scarcity of Land. Edited by, Routledge 2018. Hb: 978-1-138-20151-4

Davy, B. (2012): Land Policy: Planning and the Spatial Consequences of Property, Asgate, Farnham, Burlington, ISBN 978-0-7546-7792-5

Williamson, I.P.; Enemark, S.; Wallace, J.; Rajabifard, A. (2010): Land Administration for Sustainable Development. Published by ESRI Press Academic, Redlands, California. ISBN 978-1-58948-041-4

13	**Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14	**Date of version**

29.11.2019

Code: **GSD-04-LOBS**
Title: **Location-Based Services**

1 Content and intended learning outcomes

Content:
Navigation systems and their components; graph-theoretical concepts and algorithms for location-based services; network analysis and visualization; algorithms for routing problems; algorithms for map matching; trajectory analysis, route choice models; landmark-based navigation; cartographic visualization for navigation systems; automatic generation of schematic network maps; routing in public transport networks

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in location-based services; Specialized conceptual skills to be able to develop methods and computer programs (apps) that help people accomplish complex navigations tasks; App programming; Presentation of developed methods and systems

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Workload	Term
1	Lecture	Location-Based Services	en	15	1	45	S
2	Exercise, scientific/practical	Location-Based Services	en	15	2	75	S
3	Seminar	Location-Based Services	en	15	1	60	S

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geoinformation and Spatial Development'	2nd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	2. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral presentation	written and/or verbal academic performance	20	graded	en	25 %
Oral examination	written and/or verbal academic performance	25	graded	en	75 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

summer term

10	**Maximum number of students**
	no limitation
11	**Module coordination**
	Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	2	X	X
N.N	Institut für Geodäsie und Geoinformation	2	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J.-H. Haunert (Institut für Geodäsie und Geoinformation)

12	**Further information**
	The lecture is based on scientific conference papers and articles, for example: Robert Geisberger, Peter Sanders, Dominik Schultes, and Christian Vetter (2012): Exact routing in large road networks using contraction hierarchies. Transportation Science, 46(3):388-404. doi: 10.1287/trsc.1110.0401. Patrick Laube (2014): Computational Movement Analysis. Springer Briefs in Computer Science. Springer. ISBN 978-3-319-10267-2. doi: 10.1007/978-3-319-10268-9. Paul Newson and John Krumm (2009): Hidden Markov map matching through noise and sparseness. In Proceedings of the 17th ACM IGSPATIAL International Conference on Advances in Geographic Information Systems, GIS'09, pages 336-343, New York, NY, USA. ACM. ISBN 978-1-60558-649-6. doi: 10.1145/1653771.1653818
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	03.12.2019

Code: **GSD-05-RDEV**
Title: **Rural Development**

1 Content and intended learning outcomes

Content:
Structures, types, and trends of rural regions; Demographic and economic changes, problems of peripheral rural regions, urban-rural-cooperation, public, private, and societal stakeholders; community involvement; Rural infrastructure and land consolidation: legal background, targets, and procedures; International approaches of rural development; Theory of regional and endogenous development, LEADER approach, change management, village renewal

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in rural development; Specialized conceptual skills to be able to solve strategic problems in rural development; Ability to collect, describe, evaluate, and to interpret scientific information and to draw scientifically founded conclusions; Ability of recognition and application of complex topical relationships; Competence in transfer of knowledge to other challenges

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Rural Development	en	10	1	45	W
2	Exercise, scientific	Rural Development	en	10	2	75	W
3	Seminar	Rural Development	en	10	1	60	W

3 Prerequisites to take part the module

obligatory:
Profile Fundamentals (MGE-06)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geoinformation and Spatial Development'	3rd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral presentation	written and/or verbal academic performance	20	graded	en	25 %
Written term paper	written and/or verbal academic performance	-	graded	en	75 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Dr.-Ing. Jan Matthias Stielike	Institut für Geodäsie und Geoinformation	4	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:

Moseley, M. (2003): Rural Development: Principles and Practice. SAGE Publications, London, Thóusand Oaks, New Dehli, ISBN 978-0-7619-4767-7

OECD (2006): The New Rural Paradigm: Policies and Governance. OECD Publishing, Paris, ISBN 9264023917

Demetriou, D. (2013): The development of an integrated planning and decision support system (IPDSS) for land consolidation. ISBN 978-3-319-02346-5

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

29.11.2019

Code: **GSD-06-AAGS**
Title: **Advanced Algorithms for Geo-Information Systems**

1 Content and intended learning outcomes

Content:
Design, analysis, and implementation of algorithms for problems of spatial analysis and the visualization of spatial information; Geometric integration of spatial data; Analysis of trajectories; Map matching; Automatic generalization; Line simplification; Aggregation of spatial information; Automatic map labelling; Automation in geo-information science and cartography based on combinatorial optimization, including efficient algorithms, exact algorithms, and heuristics

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in designing, analyzing, implementing, and testing new efficient algorithms for problems related to the analysis and visualization of spatial information; Scientific writing with algorithmic terminology and mathematical rigor; Implementing software and experimenting with it

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Advanced Algorithms for Geo-Information Systems	en	15	1	45	W
2	Exercise, scientific/practical	Advanced Algorithms for Geo-Information Systems	en	15	2	75	W
3	Seminar	Advanced Algorithms for Geo-Information Systems	en	15	1	60	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
Geoinformation Systems (MGE-04)

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geoinformation and Spatial Development'	3rd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	3. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Colloquium	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 **Maximum number of students**

no limitation

11 **Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	1	X	X
Dr.rer.nat. Benjamin Niedermann	Institut für Geodäsie und Geoinformation	1	X	
Johannes Oehrlein M.Sc.	Institut für Geodäsie und Geoinformation	1	X	
Dr.-Ing. Youness Dehbi	Institut für Geodäsie und Geoinformation	1	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. J.-H. Haunert (Institut für Geodäsie und Geoinformation)

12 **Further information**

References:

de Berg, Mark, Otfried Cheong, Marc van Kreveld, and Mark Overmars (2008): Computational Geometry – Algorithms and Applications. 3rd Edition, Springer-Verlag. ISBN:3540779736 9783540779735

Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (2009): Introduction to Algorithms. 3rd Edition, MIT Press. ISBN: 9780262533058

13 **Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14 **Date of version**

30.11.2019

Master's Program
Geodetic Engineering (M.Sc. GE)
Landwirtschaftliche Fakultät
Rheinische Friedrich-Wilhelms-Universität Bonn

Code: **GSD-06-GMIRC**
Title: **Geo-Information Management in an Interdisciplinary Research**

1 Content and intended learning outcomes

Content:
Advanced concepts of spatial databases, representation of knowledge in formal ontologies, open and linked data, research data management, tools and methods for metadata annotation

Qualification goals:
The participants will learn how to manage data of different research disciplines (surveying, agriculture, robotics) and to annotate it with metadata in order to allow researchers in interdisciplinary projects to work on a common database. The problem will be studied in the context of the cluster of excellence PhenoRob, which combines machine learning approaches, robotics, and plant phenotyping for sustainable agriculture; implementing software and experimenting with it

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Geo-Information Management in Interdisciplinary Research Context	en	15	1	45	W
2	Exercise, scientific/practical	Geo-Information Management in Interdisciplinary Research Context	en	15	2	75	W
3	Seminar	Geo-Information Management in Interdisciplinary Research Context	en	15	1	60	W

3 Prerequisites to take part the module

obligatory:
none

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile ‘Geoinformation and Spatial Development’	3rd semester
Geodäsie und Geoinformation (M.Sc.)	Fachgebundener Wahlpflichtbereich: Wahlpflichtmodul "groß"	3. Fachsemester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Colloquium	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9	**Frequency**
	winter term
10	**Maximum number of students**
	no limitation
11	**Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr. Juliane Fluck	Institut für Geodäsie und Geoinformation	2	X	X
Prof. Dr.-Ing. Jan-Henrik Haunert	Institut für Geodäsie und Geoinformation	2	X	X

Module coordinator / Organisation:
Prof. Dr.-Ing. J.-H. Haunert, Prof. Dr. J. Fluck (Institut für Geodäsie und Geoinformation)

12	**Further information**
	none
13	**Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14	**Date of version**
	29.11.2019

Code: **GSD-07-LMV**
Title: **Land Markets and Valuation**

1 Content and intended learning outcomes

Content:
Structures, elements, and trends of land and real estate markets, public and private stakeholders; Interrelations between urban development and land markets; Economic, legal, and financial mathematical principles of real estate valuation; Determinants of land and real estate values; Methods of land and real estate valuation; Instruments for creating transparency on the property market; National standards of valuation methods: income approach, cost approach, sales comparison approach; International standards of valuation methods; Residual method, special tasks of valuation; Actors and institutions of land valuation

Qualification goals:
Detailed comprehensive knowledge of state-of-the-art in land markets and real estate valuation; Specialized conceptual skills to solve strategic problems in land valuation; Ability to collect, describe, evaluate, and to interpret scientific information and to draw scientifically founded conclusions; Ability of recognition and application of complex topical relationships; Competence in transfer of knowledge to other challenges

2 Teaching and learning methods

#	Type	Topic	Language	Group-size	SWS	Work-load	Term
1	Lecture	Land Markets and Valuation	en	10	1	45	W
2	Exercise, scientific	Land Markets and Valuation	en	10	2	75	W
3	Seminar	Land Markets and Valuation	en	10	1	60	W

3 Prerequisites to take part the module

obligatory:
Land Management (GSD-03-LAMA)

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Elective selection: Study profile 'Geoinformation and Spatial Development'	3rd semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Duration	graded/ not graded	Language	Weight
Oral examination	written and/or verbal academic performance	25	graded	en	100 %

6 Credits according ECTS

6 LP

7 Workload

180 h

8 Duration

1 semester

9 Frequency

winter term

10 Maximum number of students

no limitation

11	**Module coordination**

Lecturer:

Name	Organisation	SWS	exe.	res.
Prof. Dr.-Ing. Theo Kötter	Institut für Geodäsie und Geoinformation	2	X	X
Dr. Dominik Weiß	Institut für Geodäsie und Geoinformation	2	X	

Module coordinator / Organisation:
Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12	**Further information**

References:
Wyatt, P. (2013): Property Valuation, Wiley Blackwell, Oxford, UK, ISBN 978-1-119-96865-8
Lall, S.V., Freire, M., Yuen, B., Rajack, R., Helluin, J.-J. (Eds.) (2009): Urban Land Markets. Improving Land Management for Successful Urbanization, Springer Heidelberg London New York, ISBN 978-1-4020-8862-9

13	**Additional information for internal use / planning only**

Expected cost of student assistants:
no information

Expected cost of materials:
no information

Specific requirements for rooms (laboratory, computer pool, etc.):
no information

14	**Date of version**

29.11.2019

module manual

master's program
Geodetic Engineering
(M.Sc. GE)

Masterarbeit /

Master's thesis

Master's Program
Geodetic Engineering (M.Sc. GE)
Landwirtschaftliche Fakultät
Rheinische Friedrich-Wilhelms-Universität Bonn

Code: **MGE-MT**
Title: **Master's Thesis**

1 Content and intended learning outcomes

Content:
According to the Master's Thesis task

Qualification goals:
Independent and extensive analysis and interpretation of a research task; Ability to independently cope with a scientific problem in the relevant subject area on the basis of scientific methods within a set period of time; Specialized professional and conceptual skills to assess and present the research results; Systematic search of information and literature; Understanding and using scientific texts; Writing scientific text in a concise way

2 Teaching and learning methods

#	Type	Topic	Lan-guage	Group-size	SWS	Work-load	Term
1	Thesis	Master's Thesis	en	1	0	900	S

3 Prerequisites to take part the module

obligatory:
All mandatory modules

recommended:
none

4 Study program allocation

Study program	mandatory / elective module	recommended semester
Geodetic Engineering (M.Sc.)	Master's Thesis	4th semester

5 Requirements for the rewarding of credits (ECTS)

Examination(s):

Type	Prerequisites	Dura-tion	graded/ not graded	Lan-guage	Weight
Master's Thesis	all mandatory modules	-	graded	en	100 %

6 Credits according ECTS

30 LP

7 Workload

900 h

8 Duration

1 semester

9 Frequency

summer term

10 Maximum number of students

no limitation

11 Module coordination

Lecturer:

Name	Organisation	SWS	exe.	res.
all lecturers of "Geodetic Engineering (M.Sc.)"	Institut für Geodäsie und Geoinformation	---	X	X

Module coordinator / Organisation:
Prof. Dr.-Ing. T. Kötter (Institut für Geodäsie und Geoinformation)

12 Further information

	The Master's thesis is issued at the beginning of the fourth semester. The Master's thesis task is given by the examination board. According to the examination regulations the working time of the Master's thesis is at least four but not more than six months. Upon motivated request, the examination board, in agreement with the supervisor, may grant an extension of time of up to six weeks. The printed version of the Master's thesis has to be handed over to the examination board in triplicate. In addition, the thesis has to be submitted electronically in an appropriate format suited for digital inspection, such as MS Word or pdf format. The result of the evaluation of the Master's thesis shall be brought to the attention of the student eight weeks after submission at the latest.
13	**Additional information for internal use / planning only**
	Expected cost of student assistants: no information Expected cost of materials: no information Specific requirements for rooms (laboratory, computer pool, etc.): no information
14	**Date of version**
	05.12.2019