Kontaktpersonen:

Studiengangsmanager/in: Dr.-Ing. Friedrich Wilhelm Krumm
Geodätisches Institut
Tel.: 0711 685 83388
E-Mail: friedrich-wilhelm.krumm@gis.uni-stuttgart.de
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19 Auflagenmodule des Masters
### 100 Pflichtmodule

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<td>Information and Contract Law</td>
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## Modul: 41210 Advanced Mathematics

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<td>4. SWS:</td>
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<tr>
<td>5. Modulduer:</td>
<td>1 Semester</td>
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<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Univ.-Prof. Dr. Wolfgang Keller</td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Wolfgang Keller</td>
</tr>
<tr>
<td>12. Lernziele:</td>
<td>The module aims at establishing a common level of math skills for all students, smoothing out their individual entry levels. The module will provide skills to translate a problem in Geodesy into a mathematical model and to find a solution of the resulting mathematical problem.</td>
</tr>
<tr>
<td>13. Inhalt:</td>
<td>Ordinary and partial differential equations, Vector analysis, Integral theorems, Special functions, Potential theory</td>
</tr>
<tr>
<td>15. Lehrveranstaltungen und -formen:</td>
<td>• 412101 Lecture Advanced Mathematics&lt;br&gt;• 412102 Lab Advanced Mathematics</td>
</tr>
<tr>
<td>16. Abschätzung Arbeitsaufwand:</td>
<td>lectures 108 h (attendance 42h, self-study 66 h)&lt;br&gt;exercises 72 h (attendance 28 h, self-study 44 h)</td>
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<tr>
<td>17. Prüfungsnummer/n und -name:</td>
<td>• 412111 Advanced Mathematics (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0.&lt;br&gt;• V Vorleistung (USL-V), schriftlich, eventuell mündlich</td>
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<tr>
<td>18. Grundlage für ... :</td>
<td></td>
</tr>
<tr>
<td>19. Medienform:</td>
<td></td>
</tr>
<tr>
<td>20. Angeboten von:</td>
<td>Geodätisches Institut</td>
</tr>
</tbody>
</table>
Modul: 48400 Engineering Geodesy

2. Modulkürzel: 062300031
5. Moduldauer: 2 Semester

3. Leistungspunkte: 9.0 LP

4. SWS: 6.0
7. Sprache: Englisch

8. Modulverantwortlicher: Prof. Dr.-Ing. Volker Schwieger
9. Dozenten: Volker Schwieger


11. Empfohlene Voraussetzungen:

12. Lernziele:
The students are able to understand the principle of monitoring sensors, apply them for monitoring tasks and realize deformation analysis in the congruency model. Additionally they know all the details about positioning, filtering and controlling within kinematic measurement systems with a special focus on total stations. Knowledge about the graphical programming software Labview is available.

13. Inhalt:
Monitoring networks and point determination, Inclination measurements, Hydrostastical leveling, Alignment, plumbing methods, additional sensors, Monitoring analysis using the congruency model: two- and multi-epoch, comparison, global test, sensitivity test for localization of deformations, Graphical programming: introduction and data acquisition, Recapitulation of tachymeter techniques and measurements, Robot total stations, GNSS, other Kinematic measurement systems, Positioning for moving objects, Vehicle models, Prediction and filtering, e.g. Kalman filter, Basics of control theory, Integration of kinematic measurements into control circles, Construction machine guidance, Project at construction machine simulator of IIGS

14. Literatur:
• Chui, C.K., Chen, G.(1999), Kalman filtering with real time applications, Springer, Heidelberg - Berlin

15. Lehrveranstaltungen und -formen:
• 484001 Lecture Monitoring
• 484002 Laboratory Monitoring
• 484003 Lecture Kinematic Measurement Systems
• 484004 Laboratory Kinematic Measurement Systems

16. Abschätzung Arbeitsaufwand:
Monitoring, lecture, 45 h (attendance 14h, self study 31h)
Monitoring, exercise, 45 h (attendance 14h, self study 31h)
Kinematic Measurement Systems, lecture: 90 h (attendance 28 h, self study 62 h)
Kinematic Measurement Systems, exercise: 90 h (attendance 28 h, self study 62 h)
Total: 270 h (attendance 84 h, self study: 186 h)

17. Prüfungsnummer/n und -name:
• 48401 Engineering Geodesy (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
• V Vorleistung (USL-V), schriftlich, eventuell mündlich

Stand: 01. Oktober 2013
18. Grundlage für ...:

19. Medienform:

20. Angeboten von:
Modul: 41230 Geodesy

2. Modulkürzel: 062000401
5. Moduldauler: 2 Semester

3. Leistungspunkte: 9.0 LP

4. SWS: 6.0
7. Sprache: Englisch

8. Modulverantwortlicher: Prof.Dr.-Ing. Nicolaas Sneeuw

9. Dozenten:
• Friedrich Wilhelm Krumm
• Nicolaas Sneeuw

10. Zuordnung zum Curriculum in diesem Studiengang:
M.Sc. Geomatics Engineering, PO 2013 ➞ Pflichtmodule

11. Empfohlene Voraussetzungen:

12. Lernziele:
Map Projections and Geodetic Coordinate Systems
Students are enabled to interpret maps and to represent the Earth using different kinds of map projections. They are capable to investigate, to evaluate and to visualize occurring distortions. They know how to deal with different kinds of reference and coordinate systems, and to perform transformations between them.

Physical Geodesy
Students are able to judge the fundamental role of the gravity field and the geoid in all disciplines of geomatics engineering. They have the skills to select the appropriate methodological tools from physical geodesy for actual problems and projects. They understand the pros and cons of different height systems.

13. Inhalt:
Map Projections and Geodetic Coordinate Systems
Basics on differential geometry of surfaces, geometry of sphere and ellipsoid-of-revolution, spherical map projections, optimal map projections, legal map projections (Gauß-Krüger/UTM), deformations and deformation measures, 2D and 3D coordinate systems and datum transformation models

Physical Geodesy
Elements of potential theory, gravitation and gravity, measurement principles of gravimetry, gravity networks, approaches to solving the Laplace equation, special functions of physical geodesy, geoid determination, height systems

14. Literatur:

Physical Geodesy
• Sneeuw, Physical Geodesy, lecture notes, University of Stuttgart
• Matlab

Map Projections and Geodetic Coordinate Systems
• Krumm F (2012): Map Projections and Geodetic Coordinate Systems. Powerpoint viewgraphs, University of Stuttgart
• Canters F and H Decleir (1989): The world in perspective: A directory of world map projections. Wiley
15. Lehrveranstaltungen und -formen:
- 412301 Lecture Map Projections and Geodetic Coordinate Systems
- 412302 Lab Exercises Map Projections and Geodetic Coordinate Systems
- 412303 Lecture Physical Geodesy
- 412304 Lab Exercises Physical Geodesy

16. Abschätzung Arbeitsaufwand:
Map Projections and Geodetic Coordinate Systems 135 h (contact hours lectures and labs 42 h, self study 93 h)
Physical Geodesy 135 h (contact hours lectures and labs 42 h, self study 93 h)
Total 270 h

17. Prüfungsnummer/n und -name:
- 41231 Map Projections and Geodetic Coordinate Systems (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0
- 41232 Physical Geodesy (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0
- V Vorleistung (USL-V), schriftlich, eventuell mündlich

18. Grundlage für ... :

19. Medienform: blackboard, projector, Matlab

20. Angeboten von: Geodätisches Institut
Modul: 41220 Geomatics Methodology

2. Modulkürzel: 062200301
5. Moduldauer: 2 Semester
3. Leistungspunkte: 15.0 LP
4. SWS: 9.0
7. Sprache: Englisch

8. Modulverantwortlicher: Prof. Dr.-Ing. Dieter Fritsch
11. Empfohlene Voraussetzungen:
12. Lernziele:
   Statistical Inference
   The goal of this course is to impart knowledge on the most frequently applied adjustment models (model with observation equations, model with condition equations, mixed models) used in engineering disciplines and Geosciences, and their geometric interpretation. A major part will treat hypothesis testing in linear models including internal and external reliability.
   Signal Processing
   The students will learn the methodologies of signal processing. Differentiation is made between deterministic signals and random signals. FIR and IIR filters are described by difference equations, filter design is solved in time and frequency domain. Markov processes are used to simulate random signals. The filter output is applied for many examples in signal and image processing.
   Dynamic System Estimation
   The students are familiar with the methodology for parameter estimation in systems, which can be described by solutions to ordinary differential equation systems. The concept of selected random processes for the error description is understood. The students are familiar with the Kalman filter estimation procedure

13. Inhalt:
   Statistical Inference
   Basics on linear algebra, parameter adjustment, condition adjustment and mixed model adjustment, random variables, probability density functions, error propagation, hypothesis testing, internal and external reliability
   Signal Processing
   Dynamic System Estimation
   Review of Least Squares Estimation, Sequential Least Squares Estimation, Ordinary Differential Equations, numerical integration methods, linear dynamic systems, state space descriptions, random processes, state augmentation, derivation of Kalman Filter equations,
Kalman smoother, comparison of Kalman filter to sequential Least Squares Estimation

14. Literatur:

Statistical Inference
- Krumm F (2012): Statistical Inference, Powerpoint viewgraphs, University of Stuttgart
- Sneeuw N and F Krumm (2012): lecture Notes Adjustment Theory, University of Stuttgart

Signal Processing
- Fritsch, Signal Processing, lecture Materials, University of Stuttgart

Dynamic System Estimation
- Kleusberg, Dynamic System Estimation, lecture materials, Univ. of Stuttgart

15. Lehrveranstaltungen und -formen:

- 412201 Lecture Statistical Inference
- 412202 Lab Statistical Inference
- 412203 Lecture Dynamic System Estimation
- 412204 Lab Dynamic System Estimation
- 412205 Lecture Signal Processing
- 412206 Lab Signal Processing

16. Abschätzung Arbeitsaufwand:

Statistical Inference 150 h (contact hours lectures and labs 42 h, self study 108 h)
Signal Processing 150 h (contact hours lectures and labs 42 h, self study 108 h)
Dynamic System Estimation 150 h (contact hours lectures and labs 42 h, self study 108 h)
Total 450 h

17. Prüfungsnummer/n und -name:

- 41221 Statistical Inference and Signal Processing (PL), schriftliche Prüfung, 120 Min., Gewichtung: 2.0
- 41222 Dynamic System Estimation (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0
- Vorleistung (USL-V)

18. Grundlage für ... :

19. Medienform:

Videocasts, Beamer, Board, Overhead projection, Matlab

20. Angeboten von:

Institut für Photogrammetrie
**Modul: 48440 Information and Contract Law**

<table>
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<td>Univ.-Prof. Dr. Wolfgang Keller</td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Horst Speichert</td>
</tr>
</tbody>
</table>

**11. Empfohlene Voraussetzungen:**

Introduction to basics of contract law, international contract and information law as well as Internet and data protection law. Students are made familiar with methods for lawful contracts and contracts checking, especially with regard to future management positions.

**13. Inhalt:**

Introduction: Objectives and mechanism of law, The legal system (overview), The system of national law, The European system of law, International law

Contract law: General remarks, Requirements for a contract in general, Terms of contract, Irregularities in the performance of the contract, Disputes, arbitration, law-suits

Types of contract: act of sale, UN Convention on Contracts for the International Sale of Goods (CISG), contract for services, contract of work and labor

The law on torts (liability): General remarks, Tort liability based on fault, Product liability, Warranty, Compensation

Selected fields of law (overview): Labor law, The law of business associations, Company law, Commercial law, Competition law, advertising, Copyright, patent, brands and related rights

E-commerce and Internet: Web publishing, Liability, Multimedia, European legislation, IT-Security law (overview), Data protection, Privacy policy, European legislation

**14. Literatur:**

- Smith, P.F.; Bailey, S.H.: The Modern English Legal System, 1984, Sweet & Maxwell
15. Lehrveranstaltungen und -formen: 484401 Lecture Information and Contract Law

16. Abschätzung Arbeitsaufwand:
   attendance 28 h
   self study 62 h
   Total: 90 h

17. Prüfungsnummer/n und -name: 48441 Information and Contract Law (BSL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:
Modul: 41280 Integrated Project

2. Modulkürzel: 062300032  5. Modulduauer: 1 Semester
4. SWS: 0.0  7. Sprache: Englisch
8. Modulverantwortlicher: Prof. Dr.-Ing. Volker Schwieger
9. Dozenten: • Dieter Fritsch
• Norbert Haala
• Wolfgang Keller
• Alfred Kleusberg
• Volker Schwieger
• Nicolaas Sneeuw

11. Empfohlene Voraussetzungen:

12. Lernziele: The students are able to apply the knowledge of the modules of semester 1 and 2 project-related on variable topics. Additionally they know about project management, team work, scientific reporting and presentation techniques.

13. Inhalt: Variable topics are treated in projects; e.g. „geoid determination“ and „stake out of a tunnel“. The student work for ten days on the project that is structured by several working packages. The planning, measurement, evaluation and analysis are realized in small teams. The students take care about the project management in different organisational levels. The academic staff act as mentors and not as teachers. For the preparation of the measurement campaign each student has to prepare one working package including a presentation. After the measurement campaign a joint scientific report has to be realised and each student has to present his working package.

14. Literatur: • Documents/teaching materials from the modules of the 1st and 2nd semester

15. Lehrveranstaltungen und -formen: 412801 Integrated Project

16. Abschätzung Arbeitsaufwand: Integrated Project, 10 days project: 90 h (attendance time 90 h, self study 0 h)
Integrated Project, presentation and final report: 90 h (attendance 10 h, self study 80 h)
Total: 180 h (attendance 100 h, self study 80 h)

17. Prüfungsnummer/n und -name: 41281 Integrated Project (USL), Studienbegleitend, Gewichtung: 1.0

18. Grundlage für ... :

19. Medienform: laptop + LCD projector, field project

20. Angeboten von: Institut für Ingenieurgeodäsie Stuttgart
Modul: 41240 Remote Data Acquisition

2. Modulkürzel: 062100310
5. Moduldauer: 2 Semester

3. Leistungspunkte: 9.0 LP
6. Turnus: jedes 2. Semester, SoSe

4. SWS: 6.0
7. Sprache: Englisch

8. Modulverantwortlicher: Prof. Dr.-Ing. Alfred Kleusberg

9. Dozenten: • Dieter Fritsch
• Alfred Kleusberg


11. Empfohlene Voraussetzungen:

12. Lernziele: Remote Sensing
Students understand the principles of Remote Sensing of the surface of the earth from satellites in the visible light spectrum, the infrared spectrum and the spectrum of Radar signals. This includes the understanding of the complete radiation path from the source of radiation to the radiation detecting sensors, and the data communication to earth receiving stations.

Airborne Data Acquisition
Students understand the principles of direct georeferencing by GPS/IMU integration and in-situ camera calibration using extended bundle block adjustments. The photogrammetric processing pipeline consisting of image orientation, image matching and true orthophoto generation is a major subject. Airborne full waveform LiDAR and airborne RADAR complete the student's knowledge. Follow-up products such as 3D city and landscape models are also presented.

13. Inhalt: Remote Sensing (RS)
Introduction including the history of RS and an overview of modern RS systems, orbits of RS satellites, sources of electromagnetic (EM) radiation, propagation of EM radiation, interaction of EM radiation with matter, detection and measurement of EM radiation, analog to digital conversion, data transmission and storage

Airborne Data Acquisition
Principles of airborne kinematic GPS, PPP solutions, basics of IMU, GPS/IMU integration, bundle block adjustment, camera calibration using additional parameters, Image matching: from 2D correlation, least-squares and feature-based matching to semi-global matching. Automatic aerial triangulation and generation of dense surface models, orthophoto generation, airborne LiDAR and its processing (full wave form analysis), RADAR data collection, integration of RADAR and optical imagery.

14. Literatur:
Remote Sensing
• Kleusberg, Remote Sensing, lecture materials, University of Stuttgart
• ESA internet:
  http://www.esa.int/esaMI/Eduspace_EN/SEMF9R3Z2OF_0.html
• NASA internet
  http://landsat.gsfc.nasa.gov/education/tutorials.html
Airborne Data Acquisition
• Fritsch, D (2012): Airborne Data Acquisition, Lecture Notes, Univ. Stuttgart

15. Lehrveranstaltungen und -formen:
• 412401 Lecture Remote Sensing
• 412402 Lab Remote Sensing
• 412403 Lecture Airborne Data Acquisition
• 412404 Lab Airborne Data Acquisition

16. Abschätzung Arbeitsaufwand:
Remote Sensing 135 h
(contact hours lectures and labs 42 h, self study 93 h)

Airborne Data Acquisition 135 h
(contact hours lectures and labs 42 h, self study 93 h)

Total 270 h

17. Prüfungsnummer/n und -name:
• 41241 Remote Data Acquisition (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0.
• V Vorleistung (USL-V), schriftlich, eventuell mündlich

18. Grundlage für ...

19. Medienform:
Videocasts, Beamer, White Board, MatLab, IGI FlightSimulator

20. Angeboten von:
Institut für Ingenieurgeodäsie Stuttgart
Modul: 41250 Representation of Geodata

<table>
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<td>5. Moduldauer:</td>
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<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Prof. Dr.-Ing. Dieter Fritsch</td>
</tr>
</tbody>
</table>
| 9. Dozenten: | • Dieter Fritsch  
• Martin Metzner  
• Volker Walter |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Geoinformatics  
The students know internet-based technologies for the management of spatial data. They are able to use different standard web-tools. They are able to collect, model and exchange spatial data on web-platforms. They know the necessity and the advantages of storing spatial data with database management systems. They are able to model the real world with formal graphical languages and to map these models onto a relational database model.  
Thematic Cartography  
The students have competence in the basics of cartography and the creation and optimal presentation of thematic data. They will be enabled to perform the appropriate geometric, topologic and thematic modeling and presentation. |
| 13. Inhalt: | Geoinformatics  
Virtual Globes, Web 2.0 Technologies, Spatial Data Infrastructures, Web-APIs, Web-Services, Semantic Web, Database Management Systems, Database Design, Relational Model, SQL, Transaction Concept, GeoDBMS,  
Thematic Cartography  
Analysis for information systems requirements (focus on thematic maps), Scientific cartography, cognitive maps, structure of the geo-data market, Techniques of homogenizing data sets (matching and merging), Map design, animated maps, thematic maps for individual and public transport |
| 14. Literatur: | Geoinformatics  
• Fritsch, D., Geoinformatics, Lecture Notes, Univ. Stuttgart  

Stand: 01. Oktober 2013
Seite 18 von 28
• Kraak, M.-J. and Ormeling, F. J. (2003), Cartography, Visualization of Spatial Data, Harlow, Pearson
• Taylor, D.R.F (Ed.) (1998), Policy Issues in Modern Cartography, Volume 3 in Modern Cartography Series (ed. and contributor), Oxford, Pergamon
• Slocum et. al. (2005): Thematic Cartography and Geographic Visualization, 2nd ed., Upper Saddle River, Pearson Prentice Hall

15. Lehrveranstaltungen und -formen:
- 412501 Lecture Geoinformatics
- 412502 Lab Geoinformatics
- 412503 Lecture Thematic Cartography
- 412504 Lab Thematic Cartography

16. Abschätzung Arbeitsaufwand:
Geoinformatics 180 h (contact hours lectures and labs 56 h, self study 124 h)
Thematic Cartography, lecture: 45 h (attendance 14 h, self study 31 h)
Thematic Cartography, laboratory: 45 h (attendance 14 h, self study 31 h)
Total: 270 h (attendance 78 h, self study 192 h)

17. Prüfungsnummer/n und -name:
- 41251 Representation of Geodata (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0,
- V Vorleistung (USL-V), schriftlich, eventuell mündlich

18. Grundlage für ... :

19. Medienform:
Videocast, Blackboard, laptop + LCD projector, White Board, laboratory and calculation exercises

20. Angeboten von:
Institut für Photogrammetrie
200 Wahlpflichtmodule

Zugeordnete Module:

- 41300 Geo-Telematics
- 48410 Multisensor Integration
- 48430 Navigation
## Modul: 41300 Geo-Telematics

<table>
<thead>
<tr>
<th>2. Modulkürzel:</th>
<th>062300033</th>
<th>5. Moduldauer:</th>
<th>1 Semester</th>
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<td>4. SWS:</td>
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<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Dr.-Ing. Martin Metzner</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 9. Dozenten: | • Dieter Fritsch  
• Martin Metzner |

### 11. Empfohlene Voraussetzungen:

### 12. Lernziele:

**Topology and Optimization**
Based on knowledge about graph theory, the students will be able to solve topological tasks, e.g. the shortest path problem or the map coloring problem, in an optimal way. The students will be familiar with linear and quadratic and programming techniques to deal with network design problems of different orders.

**Transport Telematics**
The students are able to realize algorithms for positioning, navigation and routing. They know the structures of digital maps, which are necessary for Transport Telematics as well as some example sources. Besides they know about the interaction of different information sources as well as communication possibilities for transportation applications.

### 13. Inhalt:

**Topology and Optimization**
Graph theory and topology, Tree structures, Optimal routing and network analysis, Five-color theorem, Least-squares principle, Equality and inequality constrained least-squares estimation, Network design problems (especially Zero Order Design, First Order Design, Second Order Design), Quadratic and linear programming, Linear Complementarity Problems (LCP).

**Transport Telematics**
Digital road network, Communication technologies, Positioning and navigation systems, Traffic management systems, computer assisted operational control systems, Information services for traffic, driver assistance systems

### 14. Literatur:

**Topology and Optimization**
• Fritsch, D., Topology and Optimization, Lecture Notes, University of Stuttgart  

**Transport Telematics**
15. Lehrveranstaltungen und -formen:

- 413001 Lecture Topology and Optimization
- 413002 Lab Topology and Optimization
- 413003 Lecture Transport Telematics
- 413004 Lab Transport Telematics

16. Abschätzung Arbeitsaufwand:

<table>
<thead>
<tr>
<th>Lehrveranstaltung</th>
<th>Lecture, 90 h (attendance 28 h, self study 62 h)</th>
<th>Exercise, 45 h (attendance 14 h, self study 31 h)</th>
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<tbody>
<tr>
<td>Topology and Optimization</td>
<td></td>
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<tr>
<td>Transport Telematics</td>
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<tr>
<td>Total</td>
<td>270 h (attendance 84 h, self study 186 h)</td>
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17. Prüfungsnummer/n und -name:

- 41301 Geo-Telematics (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
- V Vorleistung (USL-V), schriftlich, eventuell mündlich

19. Medienform:

Videocasts, White Board Blackboard, laptop + LCD projector, laboratory and calculation exercises, MatLab

20. Angeboten von:

Institut für Photogrammetrie
## Modul: 48410 Multisensor Integration

<table>
<thead>
<tr>
<th>2. Modulkürzel:</th>
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<tr>
<td>3. Leistungspunkte:</td>
<td>9.0 LP</td>
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<tr>
<td>4. SWS:</td>
<td>6.0</td>
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<td>5. Moduldauler:</td>
<td>1 Semester</td>
</tr>
<tr>
<td>7. Sprache:</td>
<td>Englisch</td>
</tr>
<tr>
<td>8. Modulverantwortlicher:</td>
<td>Prof. Dr.-Ing. Dieter Fritsch</td>
</tr>
</tbody>
</table>
| 9. Dozenten: | • Dieter Fritsch
• Volker Schwieger |

### 12. Lernziele:
The students learn methods of close range photogrammetry, terrestrial LiDAR and mobile mapping. Integration of imaging with LiDAR is one major issue, used in outdoors and indoors environments. As outdoors applications use GPS and integrated GMS/IMU, for indoors the Simultaneous Localization and Mapping (SLAM) problem is introduced. Based on the information provided in this module, the students are able to build up a terrestrial multi-sensor system. They understand the different sensors and their interaction as well as their handling within the system.

### 13. Inhalt:
**Image-based data collection:**
Close range sensors (CCD, CMOS, CIR), terrestrial LiDAR, Mobile Mapping Systems, direct and indirect solutions for spatial resection, simultaneous registration using SIFT and affine SIFT operators, RANSAC algorithms, SLAM problems, Structure-and-Motion, dense point cloud generation using image matching, fusion of LiDAR and image-generated point clouds, ICP algorithms.

**Terrestrial Multisensor Systems:**
Definition of terrestrial multi-sensor systems, analogue and digital data registration, bus-based systems, analogue-digital conversion, special kinematic sensors, dead reckoning, coordinate systems, sensor corrections and reductions, synchronisation, real time data processing, evaluation using Kalman filter, project: development of a multi-sensor system

### 14. Literatur:

**Image-based data collection:**

**Terrestrial Multisensor Systems:**
15. Lehrveranstaltungen und -formen:
   • 484101 Lecture Image-based Data Collection
   • 484102 Laboratory Image-based Data Collection
   • 484103 Lecture Terrestrial Multisensor Systems
   • 484104 Laboratory Terrestrial Multisensor Systems

16. Abschätzung Arbeitsaufwand:
   Image-based Data Collection, Lecture 135 h (contact hours lecture and labs 42 h, self study 93 h)
   Terrestrial Multisensor Systems, Lecture: 135 h (contact hours lecture and labs 42 h, self study 93 h)
   Total: 270 h (attendance 84 h, self study: 186 h)

17. Prüfungsnummer/n und -name:
   • 48411 Multisensor Integration (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0
   • V Vorleistung (USL-V), schriftlich, eventuell mündlich
### Modul: 48430 Navigation

<table>
<thead>
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<th>2. Modulkürzel:</th>
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<td>8. Modulverantwortlicher:</td>
<td>Prof. Dr.-Ing. Alfred Kleusberg</td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Alfred Kleusberg</td>
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<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>Advanced Mathematics, Dynamic System Estimation</td>
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#### 12. Lernziele:

**Satellite Navigation**
- Students have a complete understanding of all aspects of satellite navigation with modern Global Navigation Satellite Systems (GNSS) like GPS or Glonass. This understanding includes the design of orbital constellation and the description of orbits. The process from signal generation, modulation and transmission over signal propagation in the atmosphere including refraction effects up to the signal demodulation and measurement in the receiver is understood. Based on this the students know the GNSS position accuracy limitations and the potential for error corrections by DGNSS.

**Integrated Positioning and Navigation**
- Students have a basic understanding of the mathematical and physical background of Strap-Down Inertial Navigation Systems. Based on this they understand the error behavior of INS with different types of inertial sensors, and the need to integrate such systems with external measurements, such as GNSS or DGNSS positions.

#### 13. Inhalt:

**Satellite Navigation**
- Definition and realization of global coordinate systems for GNSS, satellite orbits and orbit parameters, GNSS signal generation and modulation, signal propagation, ionospheric and tropospheric refraction, signal reception and pseudorange measurements, modeling of pseudorange measurements, position determination, position error assessment, DGNSS

**Integrated Positioning and Navigation**
- Coordinate systems (inertial, ECEF, local level, body, platform), parameterisation of transformations and rotations, rotational velocity, Strap-Down-Navigator differential equations, inertial sensors, integration of differential equations, error control, integration with externally provided positions.

#### 14. Literatur:

- Kleusberg, Satellite Navigation, lecture materials, University of Stuttgart
- Kleusberg, Integrated Positioning and Navigation, lecture materials, University of Stuttgart
- IS-GPS-200E Interface Control Document
- U.S. Coast Guard Navigation Center - GPS
  http://www.navcen.uscg.gov/
- ESA - Galileo
  http://www.esa.int/esaNA/galileo.html
- Russian Federal Space Agency - Glonass
15. Lehrveranstaltungen und -formen:
- 484301 Lecture Satellite Navigation
- 484302 Laboratory Satellite Navigation
- 484303 Lecture Integrated Positioning and Navigation
- 484304 Laboratory Integrated Positioning and Navigation

16. Abschätzung Arbeitsaufwand:
Satellite Navigation 135 h (contact hours lectures and labs 42 h, self study 93 h)
Integrated Positioning and Navigation 135 h (contact hours lectures and labs 42 h, self study 93 h)
Total 270 h

17. Prüfungsnummer/n und -name:
- 48431 Navigation (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1,0
- V Vorleistung (USL-V), schriftlich, eventuell mündlich

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:
400 Deutschkurse

Zugeordnete Module: 48450 German as a Foreign Language
## Modul: 48450 German as a Foreign Language

<table>
<thead>
<tr>
<th>2. Modulkürzel:</th>
<th>[pord.modulcode]</th>
<th>5. Moduldauer:</th>
<th>1 Semester</th>
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<td>4. SWS:</td>
<td>2.0</td>
<td>7. Sprache:</td>
<td>Deutsch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Dr. Karin Herrmann</td>
<td></td>
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<tr>
<td>12. Lernziele:</td>
<td>Students are able to converse about everyday situations in their studies and home, read and understand simple texts, have a command of basic grammar structures, and write about life and culture in the German speaking countries.</td>
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<tr>
<td>13. Inhalt:</td>
<td>The course aims to develop the four communication skills listening, speaking, reading, and writing, with an increased emphasis on conversational German. Students are exposed to everyday and professional situations. Students learn frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment)</td>
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<tr>
<td>14. Literatur:</td>
<td>text book according to german level</td>
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<tr>
<td>15. Lehrveranstaltungen und -formen:</td>
<td>484501 Intensive German Course</td>
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<tr>
<td>16. Abschätzung Arbeitsaufwand:</td>
<td>attendance 130 h (attendance is mandatory) self study 60 h (since most exercises and labs take place during class, self study requires less time)</td>
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<tr>
<td>17. Prüfungsnummer/n und -name:</td>
<td>48451 German as a Foreign Language (USL), schriftliche Prüfung, Gewichtung: 1.0</td>
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18. Grundlage für ... :

19. Medienform:

20. Angeboten von: