MODULE HANDBOOK

Cartography M.Sc.

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1st SEMESTER

WINTER SEMESTER

Technische Universität München, Germany

www.tum.de

Module Description

BV300025: Cartographic Foundations

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
5	150	105	45

Description of Examination Method:

The examination consists of a written exam of 90 min in total (100%). The students have to answer to the questions with own formulations, partially they have to sketch issues or circumstances. No auxiliary materials are permitted within the written exam.

The written exam is a means to measure the student's ability to understand the cartographic visualization process, the relation of cartography to other fields, the basics of geologic forces and how the different terrain shapes can be represented in a 2D map and to choose an appropriate map projection for a distinct purpose.

Additionally the students have to create a sufficient user-oriented topographic and thematic map to verify their ability to apply and evaluate cartographic concepts and typographic guidelines in the context of mapmaking.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
written	90 min	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	No	No	No

(Recommended) Prerequisites:

A basic knowledge in mathematics is desirable.

Content:

The course covers different aspects of cartography and cartographic research like:

- Fundamental cartographic concepts;
- The cartographic visualization process;
- Map and layout design;
- Cartographic generalization;
- Map projections;
- Use and user issues in cartography;
- Topographic and thematic mapping;
- The impact on forces and processes which produces geological structures.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- describe the relevance and influence of cartography to various associated fields;
- explain the cartographic visualization process;
- compare different map-projections;
- explain how map projections can be applied to geographic data;
- interpret the earth surface and summarize the processes in the earth producing geological structures and mountains and the forces sculpture the earth surface;
- explain theories of perception and effective user-driven map-design;
- create topographic and thematic maps using various visualization techniques based on cartographic concepts and the general typographic guidelines.

Teaching and Learning Methods:

The module is structured in lectures and exercises. The lectures consisting of presentations of the supervisors and blended learning like map reviews and working on reading material to current cartographic research issues.

The exercises are carried out as individual work as well as group work under supervision. Within the exercises, the students have to create a topographic and a thematic map. The students have to define and solve cartographic visualization problems and should practice their skills within the cartographic domain by using cartographic software and tools.

Feedback on the exercises (created maps and applied methodologies and techniques) is given to the groups or students by one to one discussions during the contact hours.

Media:

Moodle e-learning platform, presentations, pc-lab, discussions, reading material

Reading List:

Slocum, T. A. et al. (2008): *Thematic Cartography and Geovisualization.* Prentice Hall.

Anson, R. W., Ormeling, F. J. (1996): *Basic Cartography for Students and Technicians.* International Cartographic Association (ICA). Elsevier Science.

Robinson, A. H. et al. (1995): *Elements of Cartography.* John Wiley & Sons.

Heywood, I, Cornelius, S., Carver, S. (2006): *An Introduction to Geographical Information Systems.* Pearson Education.

Keates, J. S. (1996): *Understanding Maps.* Addison Wesley.

Kraak, M. J., Ormeling, F.J. (1998): *Cartography: Visualization of Spatial Data.* Addison Wesley.

Bugayevskiy, L. M., Snyder, J. P. (1995): *Map Projections – A Reference Manual.* Taylor & Francis.

Responsible for Module:

Liqiu Meng, liqiu.meng@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Cartographic Foundations (Lecture-Exercise, 3 SWS)

Cron J [L], Meng L, Kumke H, Murphy C, Krautblatter M

Module Description

BV300003: Geo-Information

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
6	180	120	60

Description of Examination Method:

A written exam of 60 min takes place in the end of the semester (100%). By answering the questions the student should verify that they have gained the required knowledge about spatial data management, the analysis of geodata, spatial data mining and cartographic techniques for visualising spatial data. The exam contains questions in which they have to give valid definitions, explain concepts, theoretically implement and evaluate case studies, as well as mastering design challenges. All learning outcomes are covered by this written exam.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
written	60	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	Yes	No	Yes

(Recommended) Prerequisites:

Knowledge of higher mathematics and experiences of handling spatial data

Content:

This module includes the following topics:

- Introduction to GIS;
- Spatio-temporal representations and databases;
- Spatial data analysis;
- Spatial data mining;
- Data retrieval and cartographic techniques;
- Case studies of Geoinformation;
- Introduction to ArcGIS components;
- Working with multiple data tables;
- Learning spatial analysis methods;
- Building 3D models;
- Creating animations;
- Designing a quality Map in a GIS;
- Collecting spatial data during field work;
- Integrating GPS data to a GIS;
- Publishing geographic information online.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- illustrate the dimensions of geoinformation;
- explain the structure of a GIS;
- understand data mining concepts;
- implement concepts of geodata harmonization to integrate geodata into a GIS;
- implement geostatistical methods;
- apply properties of different map projections and to select appropriate projections for specific purpose;
- implement map generalization concepts and algorithms;
- integrate the functional and the organizational workflow of geodata-management and implement them into system-architectures using established concepts of geodata modelling;
- evaluate spatial databases and the spatial data quality within geodata-management;
- create queries for geodata analysis;
- create well designed maps;
- generate three dimensional data models.

Teaching and Learning Methods:

The module is structured in lectures and exercises. The lectures provide the theoretical foundations of geoinformation. They impart knowledge about spatial data management, the analysis of geodata, spatial data mining and cartographic techniques for visualising spatial data. The exercise part of this module allows the students to employ their GIS knowledge to applied studies. An introduction to ArcGIS will be given and the students can analyse and visualise
geodata using a variety of analysis tools and visualisation techniques. A set of exercises put the theoretical knowledge into practice. The exercises are carried out in a computer lab individually, partly under supervision and partly in self-study. Feedback on the exercises is given to each student within a personal one-on-one discussion.

Media:

Moodle e-learning, presentations, script, GIS laboratory, hand-outs, recommended literature

Reading List:

Longley, P. A., Goodchild, M. F., Maguire D. J., Rhind, D. W. (Eds.) (2005): *Geographical Information Systems – Principles, Techniques, Management and Applications.* John Wiley & Sons.

Law, M., Collins, A. (2013): *Getting to Know ArcGIS for Desktop.* Esri Press.

Responsible for Module:

Liqiu Meng, liqiu.meng@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Geoinformation (Lecture-Exercise, 4 SWS)

Murphy C [L], Meng L

Module Description

BGU30045: Geovisualization and Geostatistics

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
5	150	90	60

Description of Examination Method:

The examination consists of a written exam of 120 min in total (100%) at the end of the semester. The students have to answer to the questions with own formulations partially they have to sketch issues or circumstances. No auxiliary materials are permitted within the written exam.

The written exam gives the proof that the students have understood, can reflect and can apply statistical methods to spatial data as well as different visualization approaches to spatial and non- spatial data and that they can adapt their skills under time pressure to create visualizations using a combination of spatial and non-spatial data.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
written	120	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	No	No	No

(Recommended) Prerequisites:

Knowledge of higher mathematics and experiences of spatial data handling, as well as a basic understanding of cartography and graphic design are desirable. ‘R’ programming experience is not required, but would be an advantage.

Content:

The content of this module covers geovisualization and geostatistics aspects including geomarketing which are combined to gain insights into spatial data analysis, using statistical methods and to visualize these insights using advanced visualization techniques.

During the lectures in particular topics like:

- Geovisualization vs. Information visualization;
- Geospace vs. Information space;
- Animation and anamorphosis;
- User interface design;
- Point clustering and analysis;
- Basic statistic methods and applications;
- Statistical interpolation methods like IDW, kriging, spline etc. and density surfaces;
- Components, methods and applications of geomarketing;

are covered.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- create visualizations using and combining spatial and non-spatial data;
- evaluate visualization approaches of spatial data and build new ones upon the theoretical framework;
- analyse spatial data using statistical methods;
- apply methods of explorative spatial data analysis and evaluate results;
- understand the crucial components of geostatistics;
- apply geomarketing methods.

Teaching and Learning Methods:

The module is structured in lectures and exercises. The lectures provide the theoretical foundation of geovisualization and geostatistics including geomarketing.

During the exercises, the students are gaining the possibility of applying the learned methods and methodologies to real world problems by implementing case studies to get deeper insights into cartographic- and graphic-design as well as the different statistical analysis methods. The integration of geographical intelligence into all marketing aspects including sales and distribution are introduced. The exercises are carried out individually under supervision. Feedback to the exercises is given to the students by one to one discussions during the contact hours. At the end of the semester, the students have to pass the written exam.

Media:

Moodle e-learning platform, presentations, script, pc-lab, hand-out, exercise sheets

Reading List:

Slocum, T., McMaster, R. B., Kessler, F. C., Howard, H. H. (2005): *Thematic Cartography and Geographic Visualization*. Pearson.

Hake, G., Grünreich, D., Meng, L. (2002): *Kartographie.* Walter de Gruyter.

Bertin, J. (1967): *Semiologie Graphique.* Mouton / Gauthier-Villars.

MacEachren, A. M. (1995): *How Maps Work.* The Guilford Press.

Ware, C. (2004): *Information Visualization: Perception for Design.* Morgan Kaufmann.

Tufte, E. R. (1983): *The Visual Display of Quantitative Information.* Graphics Press.

Fry, B. (2008): *Visualizing Data.* O'Reilly.

Responsible for Module:

Liqiu Meng, liqiu.meng@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Geostatistics and Geomarketing (Lecture-Exercise, 2 SWS)

Cron J [L], Murphy C, Strobl C, Zoßeder K

Visualization of Geodata (MSc. Cartography) (Lecture-Exercise, 2 SWS)

Jahnke M [L], Meng L

Module Description

BV480016: Introduction to Photogrammetry, Remote Sensing, and Image Processing

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
6	180	120	60

Description of Examination Method:

The written exam takes 120 minutes with content of Photogrammetry and Remote Sensing on one hand and Image Processing on the other hand count both 50% of the achievable points. Questions contain drawing and explaining figures, answering questions on methods and solutions, calculations or comparisons of methods and their applicability. Additionally, multiple-choice-questions are including with statements that have to be evaluated as true or false. This part does not contain more than 20% of the total points. No aids or materials are allowed.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
written	120	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	No	No	Yes

(Recommended) Prerequisites:

Linear algebra and MatLab basics for the exercises in Image Processing

Content:

- Introduction: Definition Photogrammetry and Remote Sensing;
- Characteristics of Photogrammetry, applications and development;
- Characteristics of Remote Sensing, applications and development;
- Introduction the Photogrammetry: stereoscopic vision and measurement, photogrammetric image analysis, digital stereo processing;
- Introduction to Remote Sensing: Radiometric basics, multispectral classification;
- Optical basics: models and geometric quality of optical projections, description of image quality;
- Introduction to Image Processing;
- Features of digital images;
- Image transformation, convolution, edge detection;
- Segmentation;
- Binary image processing;
- Vectorization and geometric primitives;
- Feature extraction.

Intended Learning Outcomes:

Participants are capable to:

- Analyse applications from different points of view;
- Planning aerial image campaigns;
- Understand the principles of stereoscopic records;
- Evaluate stereo records and produce anaglyphe images;
- Understand concepts of photogrammetric image analysis;
- Remember the physical basics of the electromagnetic spectrum and radiometric basics;
- Understand the principles of supervised and unsupervised classification;
- Apply different classifiers and evaluate the classification results;
- Evaluate the influence of different factors on the image quality;
- Evaluate characteristic features of images;
- Apply different image transformations,
- Analyse images by segmentation and feature extraction;
- Analyse binary images and to assess results;
- Compare image processing operations.

Teaching and Learning Methods:

Lecture: Slides and lecture notes with small examples and discussion.

Programming exercises with tutors for better understanding of the methods of image processing, home exercise for self-problem solving.

Media:

Lecture: Slides, lecture notes, whiteboard

Exercise: Working sheets, MatLab exercises

Reading List:

Haralick, Shapiro (1992): *Computer and Robot Vision (Vol. 1).* Addison-Wesley.

Castleman (1995): *Digital Image Processing.* Prentice Hall, Englewood Cliff.

Responsible for Module:

Ludwig Hoegner, Ludwig.Hoegner@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Photogrammetry and Remote Sensing (Lecture-Exercise, 2 SWS)

Stilla, U [L]

Image Processing (Lecture-Exercise, 2 SWS)

Hoegner, L [L]

Module Description

IN2026: Scientific Visualization

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
5	150	90	60

Description of Examination Method:

The exam takes the form of written test of 120 min (100%). Questions allow assessing acquaintance with concepts and algorithms of scientific visualization and visual data analysis, and the application domains where visualization methods are used. Small tasks using public domain visualization tools assess the ability to apply suitable visualization techniques to specific kinds of data and let the students become familiar with common visualization options.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
written	120	end of semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	No	No	No

(Recommended) Prerequisites:

None

Content:

Visualization pipeline (data acquisition, filtering, display), information visualization vs. scientific visualization, grids and grid construction (Delaunay triangulation), interpolation in grids (inverse distance weighting, radial basis functions), discretization aspects, visualization for scalar fields (colour coding, iso-contours and iso-surfaces, volume rendering, vector field visualization (particle-based visualization, line integral convolution, topological approaches), terrain rendering including adaptive meshing techniques and hierarchical data representations using quadtree and octrees.

Intended Learning Outcomes:

After successful completion of the module, the students have gained advanced knowledge concerning the visualization pipeline, ranging from data acquisition to the final image of this data. This includes knowledge about the application specific data representations, data interpolation and approximation techniques for discrete data sets, data filtering techniques like convolution, as well as the final mapping stage to generate a renderable representation from the data. The students know the methods which are used in scientific visualization to graphically depict 2D and 3D scalar and vector fields, including isocontouring, direct volume rendering, flow visualization, and terrain rendering. They can analyze and categorize available techniques in terms of quality, efficiency, and suitability for a particular data type, and they can model and develop new approaches considering application-specific requirements. In the practical exercises the student learn about the functionality of commonly used visualization tools, they can evaluate available tools based on their functionality, and they can apply these tools to create own visualizations of given scientific data sets.

Teaching and Learning Methods:

The module consists of the lecture and an accompanying practical exercise. In the lecture, the lecturer conveys to the students the area-specific knowledge, points towards relevant articles and encourages the students to read and put into relation the presented approaches, and gives examples demonstrating the application of these approaches.
In the practical exercises, state-of-the-art tools for scientific visualization are demonstrated online. The students are introduced to these tools so that they can use them on their own. The students are supposed to apply some of the tools for the visualization of 3D data sets from a number of different application domains.

Media:

Powerpoint course slides, white board exercises, online tutorials and demonstrations.

Reading List:

Schumann, Müller: *Visualisierung - Grundlagen und allgemeine Methoden.* Springer.

C. Hansen, C. Johnson (Ed.): *The Handbook of Visualization*. Academic Press.

Responsible for Module:

Rüdiger Westermann, westermann@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Scientific Visualization (Lecture-Exercise, 4 SWS)

Westermann, R [L], Bürger K

Module Description

BGU30046: Mapping Project

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
5	150	90	60

Description of Examination Method:

The examination consists of a presentation of content and result of the project in a 15 min oral report, including subsequent discussion (30%), preparation of a written report containing the results of the intended project as well as state of the art, applied methods and methodologies (70%).

The presentation is a means to measure the student's ability to summarize the project, to present the results to an audience in a suitable manner and to conduct a subsequent discussion about the presented project with experts. In particular, the subsequent discussion offers the possibility to evaluate the student's ability to discuss and argue on the applied cartographic techniques, principles and methodologies.

The written report measures the student's competence of developing the project from the initial idea to the complete picture. This includes understanding the intended project topic and relating them to cartographic research questions and issues, to evaluate, combine and process spatial and non-spatial data using different tools as well as to evaluate and apply different cartographic techniques, principles and methodologies to gain user- and purpose-oriented results.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Oral Presentation and Report		next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	Yes	Yes	Yes

(Recommended) Prerequisites:

The students should have a basic understanding of cartographic methodologies and techniques and a feeling for a suitable and good graphic design. Programing skills are desirable.

Content:

The content varies with the intended project topic related to cartography or comes from associated fields like:

- Geoinformation;
- Geovisualization;
- Routing (indoor and outdoor);
- Navigation;
- Cognition, and
- Usability engineering.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- understand current cartographic research issues and cartographic research questions;
- evaluate cartographic research approaches;
- analyse and process geodata within a spatial context;
- combine spatial data with other non-spatial data;
- evaluate different cartographic techniques, principles and methodologies according to the applicability to the intended project;
- create user- and purpose-oriented results for the intended project;
- discuss and present the applied cartographic/design methodologies with/to experts.

Teaching and Learning Methods:

The students are working in groups of two or three persons under supervision on current cartographic research questions/intended project topics. Based on the intended project topic they have to implement a case study, which shows the ability to create sufficient user- and purpose-oriented results, to apply appropriate methods and methodologies and to combine different kinds of data (spatial and non-spatial). Feedback to the groups concerning the implemented case study, the applied methods and methodologies as well as concerning the progress of their project is given to each group by one to one discussions during the contact hours.

Each group has to give a presentation concerning the final results of the intended project at the end of the course. Until the end of the course, each group has to accomplish a written report about the intended project.

Media:

Moodle e-learning platform, presentations, pc-lab, discussions, reading material

Reading List:

Slocum, T., McMaster, R. B., Kessler, F. C., Howard, H. H. (2005): *Thematic Cartography and Geographic Visualization.* Pearson.

Hake, G., Grünreich, D., Meng, L. (2002): *Kartographie.* Walter de Gruyter.

Bertin, J. (1967): *Semiologie Graphique.* Mouton/Gauthier-Villars.

MacEachren, A. M. (1995): *How Maps Work.* The Guilford Press.

Fry, B. (2008): *Visualizing Data.* O'Reilly.

Klanten, R., Ehmann, S., Schulze, F. (2011). *Visual Storytelling – Inspiring a New Visual Language.* Gestalten Verlag.

Responsible for Module:

Liqiu Meng, liqiu.meng@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Mapping Project (Course, 3 SWS)

Cron J [L], Jahnke M

Module Description

BV030012: Engineering Databases

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
3	90	45	45

Description of Examination Method:

In the 60-minute exam (100%) the students have to demonstrate that they understand and are able to repeat the basic working principles of database theory within a limited timeframe. Additionally, they have to identify solutions and their implementations to technical application problems under time pressure accurately.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
written	60	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	No	No	No

(Recommended) Prerequisites:

Basic programming skills

Content:

- Conceptual database design;
- Relational algebra;
- Query language SQL;
- Normalization;
- Transactions;
- Indexing;
- Engineering applications.

Intended Learning Outcomes:

After completion of the module the students will be able to:

- create a conceptual database design using the entity-relationship model;
- apply relational database theory;
- use the query language SQL;
- normalize a relational database schema;
- understand indexing structures ;
- use databases for engineering applications.

Teaching and Learning Methods:

The teaching results of the module are achieved by multiple coordinated components. The lectures are supported by PowerPoint presentations, blackboard scripts and movies illustrating computer simulations. The lecture contents are completed by exercises in the lecture hall.

Media:

Moodle e-learning platform, PowerPoint presentations

Reading List:

Elmasri R. and Navathe S. B. (2010): *Fundamentals in Database Systems*. Addison-Wesley.

Responsible for Module:

Alex Braun, alex.braun@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Engineering Databases (Lecture, 2 SWS)

Borrmann A. [L], Daum S

Module Description

BV570007: Observing and Modelling Global Dynamic Processes

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
3	90	60	30

Description of Examination Method:

The required contents of the lecture are assessed in the form of a written exam of 60 minutes (100%). The participants have to answer questions related to the course content and solve problems on the basis of provided figures.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
written	60	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	Yes	No	No

(Recommended) Prerequisites:

Participants require fundamentals in mathematics, in particular in the fields of linear algebra, differential equations and data analysis. Basic knowledge in space geodesy is desirable.

Content:

Introduction:

- System Earth: Components and Interactions;
- Observation of the Earth System from Space;
- Earth System Modelling.

Space Geodesy and Dynamic Processes in the Earth System:

- Earth rotation: Foundations and Reference Systems;
- Earth rotation: Balance of Angular Momentum in the Earth System;
- Surface Geometry: Solid Earth Deformation by Atmospheric and Oceanic Loading;
- Gravity Field: Temporal Variations and their Geophysical Interpretation.

Earth System Modelling:

- Atmospheric General Circulation Models and Reanalyses;
- Oceanic Circulation Models and Data Assimilation;
- Atmosphere-Ocean Interaction and Coupled Models.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- apply the mathematical and physical formalisms for the description of the rotation, the deformation and the gravity field of the Earth;
- evaluate observations of space geodetic observation techniques regarding information content and accuracy;
- understand geophysical processes within and interactions between various components of the Earth system;
- understand the interaction between global dynamic processes and geodetic parameters of rotation, geometry and gravity field of the Earth;
- analyse and apply models of atmosphere and ocean for geodetic applications and evaluate their results and projections;
- analyse the tasks and products of international geodetic organizations;
- discuss with experts from various geoscientific disciplines about up-to-date scientific questions and results.

Teaching and Learning Methods:

Full time lecture, interactive discussions between participants and lecturer in class on up-to-date scientific problems.

Media:

- Presentation (PowerPoint); available to participants as online course material;
- Derivations of mathematical content on the blackboard;
- Scientific articles for background reading.

Reading List:

IPCC (2007): *Climate Change 2007: Synthesis Report.* Geneva.

Emanuel, K. (2007): *What we know about climate change*. Boston Review.

Kandel, R. (1980): *Earth and Cosmos.* Pergamon Press.

Moritz, H., I. Mueller (1987): *Earth Rotation: Theory and Observation.* Ungar.

Selected scientific publications of the lecturer and other scientists (distributed in the course).

Responsible for Module:

FlorianSeitz, florian.seitz@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Earth System Dynamics (Lecture, 2 SWS)

Seitz F [L]

Module Description

BV230050: Atmospheric Physics and Remote Sensing

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
3	90	60	30

Description of Examination Method:

With a 30 min oral examination (100%) it shall be ensured that the students are able to remember and to understand the individual concepts and processes of atmosphere and its composition, weather and climate, the Earths energy budget and radiation balance, and climate predictions. The students should verify that they are able to build interrelations among these concepts, and that they have an insight into their contribution to the overarching concept of system Earth.
By means of dedicated questions, it is verified that the students are able to interpret results of observation technologies and that they are able to build connections to physical modelling. The format of an oral exam allows interactive queries, and the students are required to give precise and well-structured answers in real time.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
oral	30	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
No	No	No	No

(Recommended) Prerequisites:

Mathematics, experimental physics.

Content:

Atmospheric Physics and Remote Sensing: Introduction to atmospheric physics with an emphasis on remote sensing of atmospheric components and processes from space:

- Atmosphere, weather and climate;
- Clouds, aerosols and trace gases;
- Radiative transfer;
- Earth's energy budget;
- Remote sensing of the atmosphere;
- Climate modelling and climate change.

Intended Learning Outcomes:

After the successful conclusion of the module, the students are able to:

- understand the basic principles of atmosphere, weather, and climate;
- understand the methods for determining atmospheric composition and dynamics from space;
- apply analysis methods for practical problems related to atmosphere and climate;

- apply atmospheric remote sensing methods, and to analyse the results;
- link these topics to the monitoring of the Earth system.

Teaching and Learning Methods:
PowerPoint presentations; handouts in electronic form.

Media:
Moodle e learning platform, presentations, selected text books and scientific publications

Reading List:
Taylor, F.W. (2005): *Elementary Climate Physics*. Oxford University Press.
Wallace, J.M. and Hobbs P.V. (2006): *Atmospheric Science: An Introductory Survey.* Academic Press.
Roedel, W. (2000): *Physik unserer Umwelt: Die Atmosphaere.* Springer.
Bergmann, L. und Schaefer, C. (2001): *Lehrbuch der Experimentalphysik Band 7: Erde und Planeten.* Walter de Gruyter.

Responsible for Module:
Roland Pail, pail@bv.tum.de

Course (Type of course, Weekly hours per semester), Instructor:
Atmospheric Physics and Remote Sensing (Lecture, 2 SWS)
Kiemle C [L]

Module Description

SZ0453: English – Scientific Presentation and Writing C2

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
3	90	60	30

Description of Examination Method:

Grades for oral presentations, written homework assignments and a final oral exam of 30 min contribute equally to the final course grade. Regular attendance and active participation in class is required.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
oral	30	end of semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	Yes	Yes	Yes

(Recommended) Prerequisites:

Ability to begin work at the C2 level as evidenced by a placement test score in the range of 80 – 100 percent. (Please check current announcements as the exact percentages may vary each semester.)

Content:

This course allows students to practice for formal speaking tasks in English such as a class presentation, dissertation defence or conference talk, and for completing formal written tasks such as a journal article, report, project proposal or a literature summary.

Intended Learning Outcomes:

After completion of this module students can understand with increased ease virtually everything heard or read; they can summarize information from different spoken and written sources, reconstructing arguments and accounts in a coherent presentation, and they can express themselves spontaneously very fluently and precisely, differentiating finer shades of meaning even in more complex situations.

Teaching and Learning Methods:

This course makes use of video-taping and classroom evaluation to help students develop their public speaking skill. Techniques for evaluating one's own writing will be practiced, with opportunities to revise drafts. Oral and written peer evaluations will form a regular component of the class sessions including use of an online peer forum and online instructor feedback.

Media:

Course handouts, online platform, video taping.

Reading List:

Silyn-Roberts, H. (2000): *Writing for Science and Engineering: Papers, Presentations and Reports.* Butterworth Heinemann Publishers.

Reinhart, S. (2002): *Giving Academic Presentations.* Ann Arbor: University of Michigan Press.

Oshima, A. and Hogue A. (2006): *Writing Academic English 4th Ed.* Pearson Longman.

Wiliams, J. (2000): *Style: Ten Lessons in Clarity and Grace*. Addison Wesley Longman Co.

Responsible for Module:

Heidi Minning, minning@zv.tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Geostatistics and Geomarketing (Lecture-Exercise, 2SWS)

York G [L]

2nd SEMESTER

SUMMER SEMESTER

Technische Universität Wien, Austria

www.tuwien.ac.at

Module Description

BV300027: Cartographic Theories and Applications

TUW Department of Geodesy and Geoinformation

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
9	270	180	90

Description of Examination Method:

The examination consists of a written exam (100%) which takes place at the end of the semester and has a duration of 120 min. The students have to answer to the questions of the written exam with own formulations partially they have to sketch issues or circumstances. No auxiliary materials are permitted during the written exam.

The written exam is a means to measure the student's ability of understanding, analysing and applying fundamentals of cartographic theories, the key criteria for developing cartographic research projects and the interoperability aspect of cartographic spatial data handling.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written	120	Next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	Yes	Yes	Yes

(Recommended) Prerequisites:

Knowledge of cartographic communication principles, technology-based web mapping, as well as a basic understanding of cartographic methodology and graphic-design are recommended.

Content:

The topic of this module are major theories and methods of scientific cartography. By evaluating the research agenda of Cartography relevant paradigms are assessed. Basic knowledge concerning cartographic methodology, influencing research and scientific theories are imparted and are enriched by focusing on selected topics of current scientific interest, such as generalisation, interactivity or visualisation.

A major focus is dealing with cartographic interfaces and cartographic information systems, thus applying theories and methods of cartographic communication processes in various technological environments, such as the web. By acknowledging the principles of cartographic data handling in the context of interactive systems, interoperability, Spatial Data Infrastructures and Spatial Data Handling the relevance and importance of cartography-based interfaces and system development becomes a competence.

Lecture topics:

- Cartographic research and drivers of research;
- Cartographic research agenda;
- Advanced definitions and theories;
- Geospatial information management;
- Cartographic and model generalisation;
- Spatial data infrastructure (SDI) and standards (OGC, ISO);

- Service-oriented cartography;
- Interoperability;
- Mashups and web-services;
- OpenData and OpenGovernment data;
- Advanced interface design (theories, methods, applications);
- Modelling interactive interfaces;
- Cartographic application development.

Intended Learning Outcomes:

Upon completion of the module, students are able to…

- apply advanced cartographic theories and key criteria for developing cartographic research projects;
- apply concepts, methods and methodologies of spatial data handling;
- evaluate and judge influencing factors of cartographic projects in the context of a spatial data infrastructure;
- create components and relations of contemporary scientific cartographic projects in the realm of SDI.

Teaching and Learning Methods:

The module is structured in lectures, exercises and project work. The lectures provide the theoretical foundation of theoretical cartography, cartographic interfaces and cartographic information systems. Guest lectures of selected representatives of academia and industry gives insights into advanced cartographic topics related to research and business. Within the exercises, the students have the ability to apply the learned theories and foundations to real word applications. The exercises are carried out individually under supervision

The project work focuses on the whole picture from the initial idea to a prototype application and puts the individual steps applied during the exercises together. Until the end of the semester the students have to write a short report concerning the project topic, the applied methods and methodologies as well as about the chosen approach to solve the cartographic/visualization problem. At the end of the semester the students have to give oral presentations summarizing their project work.

The exercises as well as the project work are carried out individually under supervision. Feedback to each student is given by e-mail and by face-to-face discussions during the contact hours.

Media:

TUWEL e-learning platform, presentations, script, pc-lab, hand-out, exercise sheets

Reading List:

MacEachren, A. M. (1995): *How Maps Work: Representation, Visualization and Design*. The Guilford Press.

Kraak, M.J. et al (1996): *Cartography*. Prentice Hall.

Peterson, M. (2003): *Maps and the Internet*. Elsevier.

Dykes, J. et al (2005): *Exploring Geovisualization*. Elsevier.

Lemmers, M. (2011): *Geo-Information*. Springer.

Burghardt, D. et al (2014): *Abstracting Geographic Information in a Data Rich World*. Springer.

UN-GGIM (2014): *United Nations Global Geospatial Information Management*

Responsible for Module:

Georg Gartner, georg.gartner@tuwien.ac.at

Course (Type of course, Weekly hours per semester), Instructor:

Theoretical Cartography (Lecture, 2 SWS)

Gartner G [L]

Cartographic Interfaces (Lecture-Exercise, 2 SWS)

Jobst M [L]

Cartographic Information Systems (Lecture-Exercise, 2 SWS)

Huang H [L]

Module Description

BV300028: LBS and Multimedia Cartography

TUW Department of Geodesy and Geoinformation

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
10	300	195	105

Description of Examination Method:

The examination consists of a written exam of 120 min (30%) and a written project report (70%). The students have to answer to the exam questions with own formulations partially they have to sketch issues or circumstances. No auxiliary materials are permitted within the written exam.

The written exam measure the students ability to understand the basic concepts of location based services and multimedia cartography, the important key issues/concepts which have to be taken into account for a successful project as well as issues from related fields. Different legal and intellectual property (ip) issues have to be theoretically evaluated for locations based services (lbs) and multimedia cartography applications.

Additionally the students have to write one project report. The written project report measures the student's competence of developing three different short projects from the initial idea to a prototype application and to concatenate these projects in the context of location based services and multimedia cartography. This includes understanding the relation of the projects, to evaluate, combine and process spatial data using contemporary programming languages and frameworks, to generate results, which can be used by the subsequent projects, as well as to evaluate and apply different visualization techniques, principles and methodologies to gain user and purpose-oriented results.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written	120	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	Yes	Yes	Yes

(Recommended) Prerequisites:

Knowledge as presented by the Cartography M.Sc modules:

- Geovisualization and Geostatistics;
- Cartographic Foundations.

Recommended Cartography M.Sc. module:

- Mapping Project

Knowledge of fundamental cartographic principles, map design, web mapping, as well as a basic understanding of multimedia, web publishing and programming are recommended.

Content:

This module deals with Location-based Services. By evaluating the main components of LBS including positioning, modelling and presentation, various aspects of ongoing research are presented. Fundamental questions of LBS, including technical, economical

and legal frameworks are discussed. Development of the LBS project by applying the theoretical input into a live LBS application. A main element of LBS is applying methods of multimedia to cartography. Thus the theory, the methods and the programming of such services is key. Learning to know the fundaments and principles of cartographic data handling in the context of multimedia cartography as well as digital cartography in general is therefore element of this module.

Lecture topics in detail:

- Components and applications of location based services;
- Indoor and outdoor positioning methods and constraints;
- Modelling location based services;
- Interfaces and cartographic presentation;
- Legal, economic and technological constraints of location based services and multimedia cartography;
- Theories and applications of multimedia cartography;
- GeoCommunication;
- Interactivity and animation in multimedia cartography applications;
- Information-graphics in the domain of location based services and multimedia cartography;
- Contemporary programming methodologies and frameworks.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- understand the relations of lbs and multimedia cartography to associated fields;
- understand the fundamentals in location based services and multimedia cartography;
- understand key criteria's for developing cartographic research projects in the context of location based services and multimedia cartography;
- implement appropriate interfaces for location based services and multimedia cartography
- analyse legal constraints and intellectual property issues for lbs and multimedia cartography;
- evaluate appropriate visualization methods for lbs and multimedia cartography;
- create lbs and multimedia cartography applications using contemporary programming languages and frameworks;

Teaching and Learning Methods:

The module is structured in lectures, exercises and project work. The lectures provide in particular the theoretical foundation of location based services, multimedia cartography and associated fields like communication, graphic design and application programming.

Within the exercises, the students have the ability to apply the learned theories and foundations to real word applications in the context location based services and multimedia cartography. The exercises are carried out individually under supervision

Each student has to accomplish three different short projects. Each of the projects focuses on the whole picture from the initial idea to a prototype application and puts the individual steps applied during the exercises together. Until the end of the semester the students have to write a report covering the three different project topics, the applied methods and methodologies as well as about the chosen approach to solve the lbs or multimedia cartography problem. At the end of the semester the students have to give oral presentations summarizing their project works.

The exercises as well as the project work are carried out individually under supervision. Feedback to each student is given by e-mail and by face-to-face discussions during the contact hours.

Media:

TUWEL e-learning platform, presentations, script, pc-lab, hand-out, exercise sheets

Reading List:

Gartner, G. et al (2015): *Progress in LBS*. Springer.

Chun, L (2014): *Principle and Application Progress in LBS*. Springer.

Krisp, J (2013): *Progress in LBS*. Springer.

Cartwright et al (2007): *Multimedia Cartography*. Springer.

Responsible for Module:

Georg Gartner, georg.gartner@tuwien.ac.at

Course (Type of course, Weekly hours per semester), Instructor:
Location-based Services (Lecture-Exercise, 3 SWS)
Gartner G [L], Huang H, Retscher G, Rehrl K

Multimedia Cartography (Lecture-Exercise, 2 SWS)
Gartner G [L]

Programming Cartographic Tasks (Lecture-Exercise, 2 SWS)
Huang H [L]

Module Description

BV300029: Cartographic Publishing

TUW Department of Geodesy and Geoinformation

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
5	150	90	60

Description of Examination Method:

The examination consists of a written exam of 120 min (100%). The students have to answer to the exam questions with own formulations partially they have to sketch issues or circumstances. No auxiliary materials are permitted within the written exam.

The written exam measures the student's ability to understand basic concepts of web-mapping application and geo-media techniques. In particular, the understanding, applying and analysing the internet and press as relevant outlets of the cartographic communication processes, to formally apply these concepts using contemporary programming languages and frameworks and apply graphical design rules for visualizing spatial data.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written	120	next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	Yes	Yes	Yes

(Recommended) Prerequisites:

Knowledge as presented by the Cartography M.Sc. module:

- Cartographic Foundations

is recommended.

Content:

This module deals with contemporary ways to disseminate cartographic products. Thus a focus is geo-media techniques. By evaluating the main components of geo-media techniques including DTP, Press and PrePress, typography and design, raster image editing various aspects of ongoing research are presented. The Internet is a key media for disseminating cartographic products, thus a focus of this module is dealing with web-mapping, thus learning to know the fundaments and principles of cartographic data handling in the context of internet cartography.

Lecture topics in detail:

- Graphic data handling;
- Desktop Publishing;
- PrePress;
- Digital Printing Methods;
- Typography;
- Graphical Design;
- Raster image processing;

- Maps in the Internet;
- Map Galleries;
- Interactive Maps;
- Client-based Scripting and Markup Languages;
- Graphics and Interactivity;
- Contemporary programming methodologies and frameworks.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- understand the internet and press as relevant outlets of the cartographic communication process;
- analyse key criteria for developing geo-media and web-mapping projects;
- apply contemporary programming languages to develop web-mapping applications;
- create components and relations of contemporary geo-media techniques and web-mapping projects.

Teaching and Learning Methods:

The module is structured in lectures, exercises and project work. The lectures provide in particular the theoretical foundation of cartographic publishing in particular geo-media techniques and web-mapping as well as associated fields web-based programming.

Within the exercises, the students have the possibility to apply the learned theories and foundations to real word applications in the context web-mapping and geo-media techniques. The exercises are carried out individually under supervision

Each student has to accomplish two different short projects. Each of the projects focuses on the whole picture from the initial idea to a web-mapping application and puts the individual steps applied during the exercises together. Until the end of the semester, the students have to write a short report for each project, covering the applied methods and methodologies as well as about the chosen programming frameworks to accomplish a web-mapping application. At the end of the semester, the students have to give oral presentations summarizing their project work.

The exercises as well as the project work are carried out individually under supervision. Feedback to each student is given by e-mail and by face-to-face discussions during the contact hours.

Media:

TUWEL e-learning platform, presentations, script, pc-lab, hand-out, exercise sheets

Reading List:

MacEachren, A. M. (1995): *How Maps Work: Representation, Visualization and Design*. The Guilford Press.

Kraak, M.J. et al (2002): *Web Cartography*. Taylor & Francis.

Peterson, M. (2003): *Maps and the Internet*. Elsevier.

Dykes, J. et al (2005): *Exploring Geovisualization*. Elsevier.

Cartwright et al (2007): *Multimedia Cartography*. Springer.

Responsible for Module:

Georg Gartner, georg.gartner@tuwien.ac.at

Course (Type of course, Weekly hours per semester), Instructor:

Geo-Mediatechniques (Lecture-Exercise, 2 SWS)

Ortag F [L]

WebMapping (Lecture-Exercise, 2 SWS)

Schmidt M [L]

Module Description

BV300030: Applied Cartographic Research and Development

TUW Department of Geodesy and Geoinformation

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
6	180	105	75

Description of Examination Method:

The examination consists of reviewing a scientific paper (50%) and a project report (50%). The scientific paper covers the student's capability of writing scientifically correct research papers by using the advanced methods and methodologies. The quality of the paper shows the students ability of evaluating and applying key criteria for developing and writing research papers.

The project report shows the students ability to manage a cartographic research project from the initial idea to the final product. In particular specific characteristics of the cartographic domain different project management approaches have to be considered.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written project report		next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	Yes	Yes	Yes

(Recommended) Prerequisites:

Knowledge of fundamental cartographic principles are recommended.

Content:

This module covers advanced scientific writing and presentation methods and cartographic project management, thus is dealing with components of research-driven cartography. The Cartographic seminar includes the selection of a contemporary research topic of a current cartographic problem, scientific referencing of cartographic literature, structuring, writing and presenting. The Cartographic Project deals with learning to know the fundaments and principles of project management in the context of cartography.

Lecture topics in detail:

- Scientific sources in cartography;
- Literature inquiries;
- Advanced scientific writing and presenting;
- From the problem to the publication;
- Cartographic project management;
- Cartographic project planning.

Intended Learning Outcomes:

Upon completion of the module, students are able to:

- understand scientific papers and research projects as relevant outlets of cartographic research;
- apply the advanced methods of scientific writing and presenting;
- evaluate scientific papers and presentations in the domain of cartography;
- evaluate contemporary project management methods and methodologies according to a intended cartographic project.

Teaching and Learning Methods:

The module is structured in lectures and project work. The lectures provide in particular the theoretical foundation of advanced scientific writing and presentation methods as well as the basics of project management and project planning considering the characteristics in cartography .

The students have to accomplish two different projects. Within the first projects, the students have the ability to prove the learned theories and foundations by writing a scientific correct paper, which covers a cartographic problem based on a topic provided by the cartographic research agenda. Within the second project, the students can prove their competence in project planning and management skills.

Until the end of the semester, the students have to write a report for each project. The Projects are carried out individually under supervision. Feedback according to the projects is given to each student by e-mail or by face-to-face discussions during the contact hours.

Media:

TUWEL e-learning platform, presentations, script, pc-lab, hand-out, exercise sheets

Reading List:

MacEachren, A. M. (1995): *How Maps Work: Representation, Visualization and Design*. The Guilford Press.

Kraak, M.J. et al (2002): *Web Cartography*. Taylor & Francis.

Peterson, M. (2003): *Maps and the Internet*. Elsevier.

Dykes, J. et al (2005): *Exploring Geovisualization*. Elsevier.

Cartwright et al (2007): *Multimedia Cartography*. Springer.

Responsible for Module:

Georg Gartner, georg.gartner@tuwien.ac.at

Course (Type of course, Weekly hours per semester), Instructor:

Seminar on Cartography (Lecture-Project, 2 SWS)

Gartner G [L]

Project Map Creation (Lecture-Project, 3 SWS)

Schmidt M [L]

3rd SEMESTER

WINTER SEMESTER

Technische Universität Dresden, Germany

www.tu-dresden.de

Module Description

BV300031: Mobile Cartography

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours	Self-Study Hours	Contact Hours
9	270	170	100

Description of Examination Method:
Module and exams hold at TU Dresden: written exam, practical course work, the marks are calculated as an arithmetic mean of the marks for the practical course work (1/2) and the written examination (1/2). Within the practical course work the students will develop a mobile application related to a spatial-temporal application of their choice, such as weather forecast app, event calendar, campus finder etc. Within the written examination the students should verify knowledge and understanding related to theories and methods for data capturing, mobile UI design, positioning and sensor, context and adaptation, generalisation operators, algorithms and generalisation processes.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written	60	Next semester / End of Semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes		Yes	

(Recommended) Prerequisites:
good knowledge and practical skills in digital cartography

Content:
The course provides an overview of theories, methods and application for information delivery and cartographic presentation on mobile devices. The course structure reflects the complete processing chain and visualization pipeline starting with data capturing and integration, followed by scale dependent data modelling until adaptive information presentation on small screens. In addition theories and methods for automated generalisation and multiple representation will be presented. Lecture topics concerning mobile cartography in detail:

- introduction to mobile cartography with definitions, platforms, applications and research challenges
- mobile user interface design
- icon and map design for small screens
- positioning techniques, sensors and geosensor networks
- user generated content
- navigation, context and adaptation
- field based evaluation methods
- methods for interactive and automated generalization

Intended Learning Outcomes:
At the end of the module students are able to

- understand the complete information flow on mobile devices, considered data capturing and integration, scale dependent data modelling until adaptive information presentation
- capture and integrate geodata to mobile devices

- apply context modeling and user modeling with geodata on mobile devices
- create multiple representation of geodata on mobile devices
- create on-demand and on-the-fly generalization with geodata on mobile devices
- create mobile applications (e.g. navigation, wayfinding, orientation, tourist maps)
- apply and evaluate concepts and algorithms for generalisation of 2D- and 3D-geodata

Teaching and Learning Methods:
The module is structured in lectures and exercises. The lectures provide the theoretical foundation of mobile cartography and automated generalisation. There are guide exercises and project work carried out in supervised groups. Homeworks are done by the students individually. During a final presentation the developed apps will be presented and discussed with all students as well as with feedback from the lecture.

Media:
OPAL E-Learning platform, presentations, handouts, exercise sheets

Reading List:
Burghardt, D., Duchene, C., Mackaness, W. (2014): Abstracting Geographic Information in a Data Rich World. Methodologies and Applications of Map Generalisation. Springer Verlag.
Meng, L. Zipf, A., Winter, S. (2008): Map-based Mobile Services. Springer Verlag.
Gartner, G., Cartwright, Peterson, M. (2008): Location Based Services and TeleCartography (I+II). Springer Verlag.
Gartner, G., Ortag, F. (2012): Advances in Location-Based Services. Springer Verlag.
Duckham, M. (2013): Decentralized Spatial Computing. Foundations of Geosensor Networks. Springer Verlag.

Responsible for Module:
Dirk Burghardt, dirk.burghardt@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:
Mobile Cartography (Lecture, 2 SWS, Exercise 2 SWS, Project 1 SWS)
Burghardt D [L], Hauthal E

Module Description

BV300032: Subject-specific GIS Applications and Case Studies

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self-Study Hours:	Contact Hours:
9	270	170	100

Description of Examination Method:

Module and exams are held at TU Dresden: oral examination and assignment paper to be prepared during lecture-free period. The practical outcome, which consists of programme code plus documentation, is the main proof, that algorithms and sample programmes have been understood, and practical programming skills have been developed. Consequently, grades assigned to the project results (termed “assignment paper”) bear a 50% weight in the rating, whilst the other 50% reflect the results of the oral examination.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Oral exam and rated assignment paper	20	Beginning of summer semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	No	No	Yes

(Recommended) Prerequisites:

Introduction into geo-information systems. basic programming knowledge

Content:

Any major project demands for avoidance of time-consuming interactive data testing, analysing and transformation. In most cases interactive work flows can be formalised and automated. Customised development using existing APIs of GIS software can boost innovative solutions, quality and speed. Consequently, the module:

- exemplifies a need for automation in various geo-applications like, for instance, consistency checks, route and time demand calculation, segmentation, treatment of incomplete data, processing of dynamic phenomena
- demonstrates concepts of automation
- provides solutions for selected spatial problems, for which no built-in software solution exists
- introduces types and organisation forms of programme libraries delivered with GIS software
- offers and discusses sample codes and methods
- guides individual developments.

Intended Learning Outcomes:

At the end of the module students are able to

- remember exemplary use cases of automated geo-processing
- understand the necessity of automation in the work with geo-data

- analyse spatial problems in order to find an appropriate modularisation
- understand provided algorithms and code samples of lower complexity
- design small customised software solutions
- develop their own codes.

Teaching and Learning Methods:

The students get introduced to solutions for selected spatial problems of higher complexity, for which no built-in software solution exists within standard GIS software. Examples will mostly be taken from accomplished projects (case studies) and will comprise various fields of application. Furthermore, the student gets an introduction into types and structures of programme libraries of the software used (i.e. ArcObjects, ArcPy-Interface) and into methods of accessing these libraries in the scope of custom developments. After some guided practical programming with extensive comments on all steps, the students shall finally develop their own programmes of limited size and complexity. Such development will start under supervision and will build upon previous presentations of theory and examples. An individual completion of the development will reach into the lecture-free period. Programming tasks will be put under an umbrella topic, which will presumably vary from year to year. The thematic links between the tasks encourage communication between the participants.

Media:

Presentations, handouts (lecture notes), code sample downloads.

Reading List:

Guttag, J. V. (2013): Introduction to Computation and Programming Using Python. Cambridge (MA): MIT Press, 320 p. ISBN: 9780262525008.

ESRI. ArcGIS Resources. Online Help for Developers. *http://resources.arcgis.com/en/help/arcobjects-net/conceptualhelp/index.html#/Developing_with_ArcGIS/0001000001ww000000/*

Longley, P. A., Goodchild, M. F. Maguire, D. J. Rhind, D. W. (Editors, 2005): Geographical Information Systems: Principles, Techniques, Management and Applications, 2nd Edition, Abridged, Wiley, 404 p.

Prechtel, N. (2003): Selected Problems and Solutions for Drainage Modelling and Handling in a GIS. Kartographische Bausteine: 21(101-109). Dresden: Institut für Kartographie.

Selected lecture notes will be distributed just in time.

Responsible for Module:

Nikolas Prechtel, nikolas.prechtel@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:

Subject-specific GIS Applications and Case Studies (Lecture, 2 SWS, Exercise 2 SWS, Project 1 SWS)
Prechtel N [L+E+P]

Module Description

BV300033: Georelief and Cartography. Morphogenetic and Environmental Understanding

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self-Study Hours:	Contact Hours:
9	270	170	100

Description of Examination Method:

Module and exams held by TU Dresden, to the greatest part within the field course: the evaluation consist of a small project which has to be presented and over which the students will be examined. The coursework (exam and presentation) aims to examine the extent to which students are able to understand, describe and apply concepts and applications of cartographic geo-relief visualizations. Moreover, the whole field course shows an immanent examination character, thus reflecting the permanent active involvement of the students. Theory of geodata visualization and practice will be checked in permanent feedback.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Oral	30	possible immediately after failure

Homework:	Conversation:	Oral Presentation:	Term Paper:
Preparation of oral presentation		Yes	Yes

(Recommended) Prerequisites:

Basic geo-scientific (geography, geology) and environmental knowledge

Content:

The principal objective is to enhance the geo-thinking through a detailed presentation of an exemplary alpine landscape in close relation to methods and realizations of its cartographic depiction. Important educational targets are:

- Introduction into the dynamic natural and cultural environment of the Alpine study region and corresponding maps and geo-data (incl. satellite imagery)
- Movement and navigation (including use of LBS) in an alpine environment and mountain dangers
- Local geo-features within a wider geographical context (Eastern Alps)
- Topography and practical orientation within varying landscapes
- Field mapping using traditional and electronic data capture
- Independent thematic mapping projects.

Nearly all education is done in the field and in direct contact to the features under discussion.

Intended Learning Outcomes:

- understand local geo-features within a wider geographical context (Eastern Alps)
- understand Topography and orientate within varying landscapes

- detect Movement and Navigation (including use of LBS) in an alpine envi-ronment
- apply methods for mountain-risk-analysis with geoinformations
- create Field- maps and record geodata using electronic capture methods
- create independent thematic maps
- create cartographic products of alpine landscape considering the dynamic, natural and cultural environment of the alpine region

Teaching and Learning Methods:

The module combines on-site lectures, day excursions and practical in-situ training. 8 complete days in the field (plus 2 days for arrival and departure), comprising lectures, excursions and practical work. Individual work on a report after return. Educational stops during arrival and departure days. Educational films on landscape genesis serve as discussion bases.

Media:

presentations, handouts, literature

Reading List:

Pfiffner, O.A. (2014): Geology of the Alps. Wiley Blackwell
Anderson, R. S. (2012): Geomorphology. eBook (ePUB)
Imhof, E. (2007): Cartographic relief presentation. Esri Pr.
Harvey, A. (2012): Introducing Geomorphology: A Guide to Landforms and Processes, Dunedin Academic Press Ltd.,
Excursion guide for Alpine Field School, Institute for Cartography, TU Dresden
Various continuously updated handouts

Responsible for Module:

Dirk Burghardt, dirk.burghardt@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:

Georelief and Cartography. Morphogenetic and Environmental Understanding (Seminar, 1 SWS, and 11 days field work)
Buchroithner M

Module Description

BV300037: Remote-Sensing-based Environmental Mapping

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours	Self-Study Hours	Contact Hours
5	150	110	40

Description of Examination Method:

A oral exam takes place at the end of the semester. The exam contains questions related to the learning outcome. By answering these questions, the student should verify that he/she has gained the required knowledge about foundations of radiometry and remote sensor systems, pixel-based and object-based image analysis as well as applications related to local and global scales.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
oral	20	Next semester / End of Semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
			Yes

(Recommended) Prerequisites:

basic skills in remote sensing and GIS with special emphasis on applications in international cooperation

Content:

The module provides information on sensor characteristics and on basic as well as advanced methods of environmental remote sensing with special regard to the analysis of multi-level space- and airborne digital imagery. Applications of regional to global environmental mapping are presented and discussed, in detail:

- foundations of radiometry and remote sensor systems
- libraries of spectral signatures of land and ocean surfaces
- pixel-based and object-based image analysis
- case studies in local to global scales

Intended Learning Outcomes:

Students are able to

- handle multi-sensor remote sensing data,
- interpret and classify airborne and spaceborne imagery based on hybrid approaches,
- adapt existing and to develop new strategies for multi-scale monitoring,
- assess land cover change and its dynamics,
- integrate remote sensing environmental mapping with geoinformation systems,
- deal with various types of spatial analysis towards environmental mapping.

Teaching and Learning Methods:

The module is focusing on lectures together with interactive discussion. The theoretic framework and application-oriented perspectives are presented and discussed by an integrated approach of teaching and teamwork with students. Case studies are analyzed in detail and application-oriented multi-thematic knowledge is communicated by a participatory teaching approach.

Media:
OPAL-e.learning platform, presentations, handouts

Reading List:
Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. (2008): Remote Sensing and Image Interpretation, 6th ed. Wiley.
Jones, H.G. & Vaughan, R.A. (2010): Remote Sensing of Vegetation: Principles, Techniques, and Applications. Oxford University Press.
Sabins, F.F. (2007): Remote Sensing: Principles and Interpretation, 3rd ed. Waveland Press.

Responsible for Module:
Elmar Csaplovics, elmar.csaplovics@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:
Remote-Sensing-based Environmental Mapping (Lecture, 2 SWS)
Csaplovics E

Module Description

BGU30042: History of Cartography

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours	Self-Study Hours	Contact Hours
5	150	110	40

Description of Examination Method:

Module and exams are held at TU Dresden: oral examination and assignment paper to be prepared during lecture-free period. The exam contains questions related to the learning outcome. By answering these questions, the student should verify that he/she has gained the required knowledge about influence of historic maps for the contemporary forms of ubiquitous geospatial information distribution. Furthermore they can explain how economic, political, historical, topographical, ethnic, religious, and military factors influences map use and map production.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
oral	20	Next semester / End of Semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
		Yes	Yes

(Recommended) Prerequisites:

Students of the International Master Cartography; any other

Content:

The module combines theoretical understanding of the history of cartography with analytical and practice-based interpretation of maps. In particular authorship and development of cartography starting with the earliest cartographic awareness in prehistoric times, up to different cartographic understanding of the world over the decades.

Intended Learning Outcomes:

The students will learn how maps were produced considering economic, political, historical, topographical, ethnic, religious, and military factors. The different methods of preparation for cards and the respective connected restrictions with regard to the information that could be transmitted are presented. As part of the module, students will analyze and discuss a large number of maps. After participating the students have an understanding of the importance of the history of cartography for the contemporary forms of ubiquitous geospatial information distribution. Furthermore, a basic understanding is given that maps have a strong visual power and that maps are influenced by the perspectives of the client (map user) and the mapmaker.

Teaching and Learning Methods:

2 week-hour of lectures

Media:

presentations, handouts, literature

Reading List:

Liebenberg, E. & Demhardt, I.J. (2012): History of Cartography. International Symposium of the ICA Commission, 2010. Lecture Notes in Geoinformation and Cartography / Publications of the International Cartographic Association (ICA)), Springer.

Max Eckert's Kartenwissenschaft – the turning point in German cartography∗e. In: Imago Mundi: The International Journal for the History of Cartography, 0308-5694 (Print), 1479-7801 (Online), 38, 1, 1986.

Eckert, M. (1921/1925): Die Kartenwissenschaft. 2 Bände. Vereinigung wissenschaftlicher Verleger, Berlin/Leipzig 1921/1925.

Responsible for Module:

Manfred Buchroithner, manfred.buchroithner@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:

History of Cartography (Lecture, 1 SWS, Exercise, 1 SWS)

Jeney J

Module Description

Laser Scanning and DTM Generation

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours	Self-Study Hours	Contact Hours
5	150	110	40

Description of Examination Method:

Module and exam hold at TU Dresden: A written exam takes place at the end of the semester. The exam contains questions related to the contents of the lectures and computer lab exercises.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written	90	2x per year

Homework:	Conversation:	Oral Presentation:	Term Paper:
yes	--	--	--

(Recommended) Prerequisites:

Basic knowledge in geo-information science, relevant practical computer skills

Content:

The course provides an overview on laser scanning and DTM generation techniques, including theoretical background, sensor technology, measurement systems, algorithms and data processing methods as well as application examples. Special focus will be put on aspects of accuracy and reliability of 3D information.

Lecture topics in detail:

- Airborne laser scanning, DTM generation, 3D city models, bathymetry, biomass estimation
- Digital airborne cameras, DTM generation from stereo imagery, advanced image matching techniques
- Direct georeferencing techniques

Intended Learning Outcomes:

At the end of the module students are able to

- Know and judge the principle and potential of different DTM generation techniques
- Understand airborne, mobile and terrestrial laser scanning techniques
- Assess the quality of laser scanner products
- Apply image matching techniques and judge the quality of their results
- Find the suitable technique and system configuration for 3D data acquisition tasks
- Evaluate the potential of photogrammetry and laser scanning in various application fields

Teaching and Learning Methods:

The module is structured in lectures and exercises. The lectures provide the theoretical foundations of laser scanning and photogrammetric DTM generation. There are guided computer lab exercises carried out in supervised small groups. Homework is done by the students individually.

Media:

OPAL E-Learning platform, handouts, exercise sheets, software programs

Reading List:

Vosselman, G., Maas, H.-G. (2010): Airborne and Terrestrial Laser Scanning. Whittles Publishing, CRC Press, 336 pages

ISPRS Journal of Photogrammetry and Remote Sensing: Special Issue on Airborne Laser Scanning (Eds. A. Wehr and U. Lohr), Volume 54, Issue 2-3, July 1999

Photogrammetric Week 2011 (Ed. Dieter Fritsch) → Papers on semi-global matching (http://www.ifp.uni-stuttgart.de/publications/phowo11/index.en.html)

Mostafa, M., Hutton, J., 2001: Direct Positioning and Orientation Systems. How Do They Work? What is the Attainable Accuracy? Proceedings 2001 ASPRS Annual Meeting

Responsible for Module:

Hans-Gerd Maas, hans-gerd.maas@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:

Laser Scanning and DTM Generation (Lecture, 1 SWS, Exercise 1 SWS)

Maas, H.-G. (L); Westfeld, P. (E); Kroehnert, M. (E)

Module Description

Geodata Infrastructures

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours	Self-Study Hours	Contact Hours
5	150	100	50

Description of Examination Method:

Module and exams hold at TU Dresden: written exam, practical course work, the final marks are taken of the written exam, only if the course work is not successful it will marked '5' and weighted with 30% in the final marks. Within the practical course work the students will set a GI services (e.g. Map Services). Within the written examination the students should verify knowledge and understanding related to theories and methods on Spatial Data Infrastructures, Organisation Models, Regulations, GI Service Techniques for and related Software Architectures.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written	90	Next semester / End of Semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes		Yes	

(Recommended) Prerequisites:

good knowledge and practical skills in GIS Application, Basic knowledge in Computer Science and Programming

Content:

The course provides an overview about organizational and technical aspects of Geodata Infrastructures (GDI), about regulations and frameworks, about foundations of interoperability for geoinformation and related research.

Intended Learning Outcomes:

At the end of the module students

- have comprehensive about current GDI developments and foundations
- are able to design and develop geoinformation services and to publish geodata in GDIs
- are able to use and assess related tools and methods for setting up geoinformation services
- apply context modeling and user modeling with geodata on mobile devices

Teaching and Learning Methods:

The module is structured in lectures and exercises. The lectures provide the theoretical foundation of GDI. There are guide exercises and project work carried out in supervised groups. Homeworks are done by the students individually. The geoinformation services realized by the students will be presented and discussed with all students and will receive feedback from the lecturer.

Media:

OPAL E-Learning platform, presentations

Reading List:

Bernard, L., Mäs, S., Müller, M., Henzen, C., Brauner, J. (2014): Scientific Geodata Infrastructures: Challenges, Approaches and Directions. International Journal of Digital Earth. 7(7):613-633.

Masser, I., 2010. Building European Spatial Data Infrastructures. 2nd Edition. Redlands, CA: ESRI Press.

http://inspire.jrc.ec.europa.eu

Responsible for Module:

Lars Bernard, lars.bernard@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:

Geodata Infrastructures (Lecture, 2 SWS, Exercise/Lab 1 SWS)

Bernard L [L], Mäs S [E]

Module Description

Virtual 3D Landscape Models

TUD Faculty of Environmental Sciences

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	winter semester

Credits:	Total Hours:	Self-Study Hours:	Contact Hours:
5	150	110	40

Description of Examination Method:

Module and exams are held at TU Dresden. Digital assets and assignment paper will be prepared partly in exercises associated with the module and partly during lecture-free period. The submission will consist of defined model contents associated by a comprehensive documentation to report on methods and techniques used and quality achieved. The results will document to what degree a student has understood the principles of 3D geo-content generation, model assembly and the underlying workflow. Grades are assigned to documented practical results (termed “assignment paper”).

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Assignment paper		resubmission during summer semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	No	No	Yes

(Recommended) Prerequisites:

Introduction into geo-information systems, theory of geo-visualisation on a graduate level.

Content:

Geo-data sources serving the generation of virtual 3D models in terms of geometric and visual surface properties are progressively available. The generation of a virtual landscape model, however, is no standard process. Different use context and related design options of representations of existing or past environments will be presented. Central is an introduction to a comprehensive workflow leading from established geo-data sources (e.g. aerial imagery, digital terrain model) to a textured 3D model. Upgrades of heterogeneous primary data to a 3D model will be treated not only in theory, but essential processing steps will have to be performed by each participant.
The module:

- presents concepts of virtual 3D landscape models
- exemplifies different use context and implications on the model design
- shows potential input data sources
- discusses consistency demands within and among input sources
- offers a comprehensive workflow as an example
- demonstrates collaborative use of different software products
- guides practical implementation.

Intended Learning Outcomes:

At the end of the module students are able to

- remember applications of virtual 3D landscape models
- consider the range of design options
- choose suitable input data for 3D landscape models
- understand necessity of quality and consistency control
- produce 3D content of moderate complexity
- combine 3D content into a simple model.

Teaching and Learning Methods:

The students get involved with 3D models of real environments. Existing individual experience of the participants, be it through virtual globes, gaming, or other applications, will be used in order to discuss design, complexity, and appropriateness of such models. The lecture will demonstrate collaboration of different input as well as necessity and modes of processing. Lecture and exercise contents will be interlocked. Hands-on training will concentrate on a few selected processes as consistency testing, small 3D object design and geo-object fusion into a model. Practical work will start under supervision. The completion of a small project - basis for a final grading - will reach into the lecture-free period. Theoretic considerations, practical experiences, and self-evaluation of the results form mandatory parts of a documentation as part of the individual submission.

Media:

Presentations, handouts.

Reading List:

Team of Authors: Blender 3D: Noob to Pro. Wikibook. https://en.wikibooks.org/wiki/Blender_3D:_Noob_to_Pro

Prechtel, N. (2015): On strategies and automation in upgrading 2D to 3D landscape representations. Cartography and Geographic Information Science (CaGIS) 42:3, pp. 244-258. DOI: 10.1080/15230406.2014.987696, 15 p

Prechtel, N.; Münster, S.; Kröber, C.; Schubert, C. and Schietzold, C. (2013): Presenting Cultural Heritage Landscapes – From GIS via 3D Models to Interactive Presentation Framework. In: ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, II-5:W1, pp. 253-258.

Ruzínoor, C., M., Shariff, A. R. M., Mahmud, A. R. and Pradhan, B. (2012): 3D Terrain Visualisation for GIS: A Comparison of Different Techniques. In: Buchroithner (Ed.), True-3D in Cartography, pp. 265-277: Springer Berlin Heidelberg.

Selected lecture notes will be distributed just in time.

Responsible for Module:

Nikolas Prechtel, nikolas.prechtel@tu-dresden.de

Course (Type of course, Weekly hours per semester), Instructor:

Virtual 3D Landscape Models (Lecture, 1 SWS, Exercise 1 SWS, Project 1 SWS)
Prechtel, N. [L+E+P]

Module Description

BGU30047: Distance Course Principles of Databases

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	9 weeks	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
5	140	140	Distance education

Description of Examination Method:

The examination consists of a written exam of 120 min (100%) at the end of the semester. The students have to answer to the exam questions with own formulations, partially they have to mark answers of multiple-choice questions. The exam contains questions related to fundamentals of database management and designing, SQL queries and problems covered in the unit tests.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written (Blackboard)	120	in 5 weeks after the actual final exam

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	No	No	No

(Recommended) Prerequisites:

- Basic computer handling skills;
- Some familiarity with Windows software;
- Secondary school discrete mathematics and linear algebra;
- Ability to explore new software and new data sets.

Content:

Geoinformation professionals should be aware of databases as one of the fundamental technologies in their field. Databases are typically used to organize very large, well-structured data collections for multiple user groups and purposes. This is especially important to organizations in which the information provisioning (internally as well as externally) is a critical success factor to the organization's mission. But database technology can also be extremely useful in smaller, one-off single-user projects with a short life-cycle. This presents the rationale for the course.

This course introduces the notion of database and data manipulation. We focus on thematic (also known as attribute) databases, the relational data model, and queries in the query language SQL. Database engineering as we discuss it in this course is an important tool for any type of information management. The techniques learned in this course will be useful throughout the further study, and indeed later in professional life.

Lecture topics in detail:

- Introduction to database technology;
- Database management systems;
- Relational data model;
- Logic & Set theory;
- Principles of data extraction from databases;

- Operating on databases using mathematics in queries;
- JSP Queries;
- Parametric & Nested queries;
- Summary Queries;
- Database updating;
- Introduction to database design;
- Database implementation.

Intended Learning Outcomes:

Upon successful completion of this module, the student is able to:

- explain the fundamentals of the relational data model;
- formulate simple queries in mathematics and predicate logic;
- define, execute and verify SQL queries against an existing relational database;
- understand the first principles of database design;
- understand when to apply database technology and when not;
- remember the knowledge of mathematical logic, statistics, GIS and remote sensing.

Teaching and Learning Methods:

This is a distance education module. All learning activities, including the examinations take place through the Blackboard electronic learning environment.

Each lesson in a unit contains the following elements:

- Demonstration, a digital movie which shows certain theoretical concepts in 'action';
- Exercise, in three forms of discussion (using the Discussion board on Blackboard), Mathematical exercises (using our educational applet) and Quizzes;
- Self-tests, to help students assess their knowledge typically after completion of a lesson.

Media:

Blackboard learning platform, courseware package in offline and online format including: lectures, exercises, quizzes, demonstrations, self-tests and books.

Reading List:

Date, C. J. and Date, C. J. (1990): *An introduction to database systems (Vol. 7)*. Addison-Wesley.

Elmasri, R. (2008): *Fundamentals of database systems*. Pearson Education.

Jeff Ullman (1990): *Principles of Database and Knowledge-Base Systems*. Computer Science Press.

Stephens, R. K. and Plew, R. R. (2001): *Database Design*. SAMS.

Ramakrishnan, R. and Gehrke, J. (2003): *Database Management Systems (Vol. 3).* McGraw-Hill.

Responsible for Module:

Parya Pasha Zadeh, p.pasha@utwente.nl

Course (Type of course, Weekly hours per semester), Instructor:

Distance course of 9 weeks at 14 hrs per week

Parya Pasha Zadeh [L]

Module Description

BGU30048: Distance Course in Spatial Decision Support Systems

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	9 weeks	winter semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
5	150	136	4 synchronous and 10 a-synchronous

Description of Examination Method:

The examination consists of a written exam of 120 min (100%) at the end of the semester. The students have to answer to the exam questions with own formulations partially they have to mark answer of multiple-choice questions. The exam contains questions related to the learning outcome. By answering these questions under time pressure, the student should verify that he/she has gained the learning outcomes 1,2,4,5,7 listed below about Spatial Decision Support Systems (SDSS), definitions of decision making and framework of decision making processes, methods and software tools for spatial decision support and particularly spatial multi-criteria evaluation. Questions to the accomplished exercise are as well included within the exam. In addition, the exam tests concepts applied to a realistic case study of applying SMCE.

To pass the exam the student must have at least 60% of the total points of the written exam.

Type of Examination:	Duration of Examination (min):	Repeat Examination:
Written	120	Next semester

Homework:	Conversation:	Oral Presentation:	Term Paper:
Yes	Yes	No	No

(Recommended) Prerequisites:

Experiences of handling spatial data, as well as a basic understanding of geographic information systems.

Content:

This course introduces participants to techniques for selecting and processing data, I view of decisions to be made to generate meaningful and timely information to support the better management of resources. To improve decision making, the required information, tools, techniques, models and decision-making procedures can be integrated in a user-friendly information processing system called a spatial decision support system (SDSS). In contrast to other geo-information systems, an SDSS provides insight into assessments of trade-offs between the various spatial management options under different scenarios open to decision makers, for instance in location-allocation problems. The course provides state of the art developments to prepare students for inclusion of SDSS as part of their research thesis. We particularly address the development and continuity of web-based SDSS as well as collaborative SDSS and serious games in decision rooms.

Lecture topics in detail:

- Why do we need to support decision makers?
- Perspectives on the decision-making process;
- What is the role of spatial decision support systems in the decision-making process?
- Basic principles of multicriteria analysis;
- Spatial multicriteria analysis;

- State of the art development in Spatial Decision Support Systems;
- Application of the theory of the decision-making process, multicriteria analysis and spatial multicriteria analysis to case studies. Cases from different disciplines can be chosen.

Intended Learning Outcomes:

Upon completion of the module, students are able to…

- explain the principles of decision-making processes and decision support systems;
- distinguish between various phases of the decision-making process and their required types of information;
- discuss the linkages between GIS and decision support systems;
- apply spatial multi-criteria decision analysis techniques to combine various layers of information "criteria" of different quality, format and type to support the planning and decision-making process;
- classify and compare different multi-criteria evaluation techniques;
- use spatial multi-criteria evaluation techniques in proposing an appropriate solution to a spatial problem;
- assess and interpret the results of the multi-criteria evaluation process;
- develop state of the art research questions about spatial decision support systems.

Teaching and Learning Methods:

The distance course module is highly structured in times lectures and exercises. The lectures provide the theoretical foundation of Spatial Decision Support Systems.

Within the exercise, the students have the ability to apply the learned theories and foundations to real world applications. A realistic case study allows students to integrate their understanding obtained from individual readings and exercises. The exercises are carried out under supervision. Feedback on the exercise is given to each student by discussion board forum and with web-based meetings (the discussion board forum and the web-based meetings are substituting the face to face discussion) via Blackboard.

To that end, the student is expected to independently follow a very highly structured series of lessons, of different reading assignments and exercises. Additionally 3-4 web-based meetings will be organized to address questions and assess learning progress. Students receive feedback on exercises and on forum discussions. Hence, a-synchronous contact hours are approximately 10 hrs.

Media:

Blackboard e learning platform, screencasts, micro-lectures, animation video's, papers, exercises, web-conferencing.

Reading List:

Ackoff, R. L. (1981): *The art and science of mess management.* Interfaces 11(1): 20-26.

Boerboom, L. G. J. and O. OskayAlan (2013): *Sistributed open source web-application for spatial multi-criteria evaluation for decision support systems infrastructure.* In: International Journal of Multicriteria Decision Making, 3(2013)2/3, pp. 114-128.

Bojesen, M., Boerboom, L.G.J., Skov-Petersen, H. (2015): *Towards a sustainable capacity expansion of the Danish biogas sector.* Land Use Policy 42: 264-277.

Sharifi, A., et al. (2004): *Spatial Decision Support System*. Enschede, the Netherlands, International Institute for Geo-information Science and Earth Observation (ITC).

Zucca, A., et al. (2008): *Application of spatial multi-criteria analysis to site selection for a local park: A case study in the Bergamo Province, Italy.* Journal of Environmental management 88: 752-769.

Responsible for Module:

Luc Boerboom, l.g.j.boerboom@utwente.nl

Course (Type of course, Weekly hours per semester), Instructor:

Distance course of 9 weeks at 14 hrs per week

Dr. Luc Boerboom [L] and Dr. Johannes Flacke

4th SEMESTER

SUMMER SEMESTER

Technische Universität München, Germany

www.tum.de

or

Technische Universität Wien, Austria

www.tuwien.ac.at

or

Technische Universität Dresden, Germany

www.tu-dresden.de

or

University of Twente, The Netherlands

www.utwente.nl

Module Description

BGU0MTCA15: Master’s Thesis

TUM Department of Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester

Credits:	Total Hours:	Self Study Hours:	Contact Hours:
30	900	900	0

Description of Examination Method:

The Master's Thesis is a scientific elaboration within a time period of six months. The students work on specific complex research questions in cartography and develop solutions of their own by applying the scientific background acquired during their studies.

By means of a written thesis the students explain the chosen approach and demonstrate their ability to precisely analyze the proposed method and to put it into the scientific context. The students should verify that they are able to investigate in a self-contained manner a new scientific topic related to cartography. This includes in detail, depending on the topic, the search and review of literature, topic-related methods and concepts, the development of theoretical concepts, methodologies, methods, to implement related algorithms, to apply them to specific problems, to analyse and to assess the results, and to develop and derive conclusions.

The written thesis is accompanied by a Master´s Thesis Colloquium of 60 min in total (presentation and discussion). In the oral presentation, the students shall verify that they are able to give a presentation on a self-contained investigated scientific subject in front of a larger audience in order to demonstrate the ability to communicate found solutions and scientific content in a clear way. In addition, students shall verify that they are able to discuss and defend their own work in front of a scientific audience.

Different forms of assessment (written and oral) are necessary, because different competencies are verified by this. The Master’s Thesis must be submitted in written form, by which mainly thematic and methodical competences as well as competencies to structure a written scientific document and to properly reference related work are verified. In contrast, the Master’s Thesis Colloquium must be held in oral form. Via the presentation and defence (interactive scientific discussions with the scientific audience), the overarching understanding of the thesis topic, self-competencies and soft-skills such as skills of presentation, didactics and rhetoric can be verified. The grade is determined by weighted mean of the Master's Thesis (80 %) and the Master's Thesis Colloquium (20 %).

Type of Examination:	Duration of Examination (min):	Repeat Examination:	
Report and Oral Presentation	60 min	No	
Homework:	**Conversation:**	**Oral Presentation:**	**Term Paper:**
No	No	Yes	Yes

(Recommended) Prerequisites:

Required, required-elective and elective modules of the first 3 semesters

Content:

This module is offered by all partners (all four collaborating universities, TUM, TUW, TUD, UT). The universities propose suitable topics from their subject area, mostly an aspect of one of their research projects. They support the students in the acquisition of the scientific skills to investigate broadly an aspect of a subject area and based on that to answer a problem in the corresponding area with the use of scientific methods.

Under guidance students familiarize themselves with an area in cartography. They obtain a problem in that area which is still quite general, i.e. not yet specified concretely. They have to investigate and evaluate different approaches to solve the problem, and then decide for one path which is then to be executed.

Intended Learning Outcomes:

After the elaboration of the master's thesis the graduates know how to:

- rapidly become acquainted with a specific and complex subject area in cartography;
- embed a scientific problem in a scientific and technical environment;
- identify all important aspects of those parts in cartography which are necessary for finding a solution;
- develop algorithms and methods for solving problem-specific tasks based on the scientific background acquired during their studies;
- analyse and to evaluate the results;
- present the relevance and context of the topic, the scientific questions, the methodologies employed for their solution; the results and discussion in a professional, well-structured written report;
- properly reference related work;
- present their results to a scientific audience.

Teaching and Learning Methods:

Self-study, regular discussions with the supervisor.

Media:

Not applicable.

Reading List:

To be researched independently according to the scope of work.

Responsible for Module:

Liqiu Meng, liqiu.meng@tum.de

Course (Type of course, Weekly hours per semester), Instructor:

Master´s Thesis

Meng L [L]