MASTER'S PROGRAMME IN GEOINFORMATICS
ACADEMIC YEARS 2018-2019, 2019-2020

Courses:

GIS-E1010: Geodesy and Positioning L, 5 cr
GIS-E1020: From Measurements to Maps L, 5 cr
GIS-E1030: Introduction to Spatial Methods, 5 cr
GIS-E1040: Photogrammetry, Laser Scanning and Remote Sensing L, 5 cr
GIS-E1060: Spatial Analytics L, 5 cr
GIS-E1070: Theories and Techniques in GIS L, 5 cr
GIS-E3010: Least-Squares Methods in Geoscience L, 5 cr
GIS-E3020: Digital Image Processing and Feature Extraction L, 5 cr
GIS-E3030: Advanced Laser Scanning L, 5 cr
GIS-E3040: Advanced Photogrammetry L, 5 cr
GIS-E3050: Advanced Remote Sensing L, 5 cr
GIS-E4020: Advanced Spatial Analytics L, 5 cr
GIS-E4030: GIS Development L, 5 cr
GIS-E5030: Physical Geodesy L, 5 cr
GIS-E5040: Mathematical Geodesy L, 5 cr
GIS-E6010: Project Course L, V, 10 cr
GIS-L8010: Research Seminar in Geoinformatics L, V, 1 - 10 cr
GIS-L8020: Scientific Practices and Principles in Geoinformatics L, V, 1 - 10 cr
GIS-L8030: Doctoral Studies in Photogrammetry L, V, 1 - 10 cr
GIS-L8040: Doctoral Studies in Remote Sensing L, V, 1 - 10 cr
GIS-L8050: Doctoral Studies in Laser Scanning L, V, 1 - 10 cr
GIS-L8060: Doctoral Studies in Geodesy and Navigation L, V, 1 - 10 cr
GIS-L8070: Doctoral Studies in Geoinformation Technology L, V, 1 - 10 cr
GIS-L8080: Doctoral Studies in Cartography L, V, 1 - 10 cr

GIS-E1010 Geodesy and Positioning L (5 cr)
GIS-E1010 Geodesia ja paikannus
GIS-E1010 Geodesi och positionering

Status of the Course: Master's Programme in Geoinformatics, common studies (compulsory)
Level of the Course: Master's level, doctoral level
Responsible teacher: Martin Vermeer
Teaching Period: I (autumn term)
Workload: Lectures (24 h), assignments (52 h), self-study (40 h), preparation for examination + examination (19 h)
Learning Outcomes:
To plan using a total station to set up simple survey networks. To plan using static GNSS to measure geodetic base networks. To do field reconnaissance using documents, software and field visit. To prepare point documentation. To understand the workings of code and carrier-phase GNSS, their precisions, and what they can be used for. To understand mapping measurements with total station or real time kinematic GNSS and their entry into a geographic information system. To understand traditional and modern co-ordinate reference systems and their differences, to do co-ordinate conversion between them, and the concept of datum. To understand orthometric, normal, and ellipsoidal (GNSS) heights and conversions between them, the concepts of geoid and geopotential. Technical measurements, engineering geodesy, deformation measurements, geodetic metrology (basic). Satellite and space geodetic techniques, SLR, VLBI, the motions of the Earth in space, terrestrial and celestial co-ordinates (basic). Navigation concepts: GNSS, inertial, sensor integration, linear predictive filtering (basic).
Content:
The course prepares for planning or executing simple geodetic measurements and computations in the form of base and mapping surveys. Of measuring equipment, total station (tacheometer), level and satellite receiver both in static and real-time kinematic mode are discussed. Reference systems, map projections and height systems basics. Geodetic forward and reverse problem, 2-D Helmert transformation. A little about engineering surveys and instrument calibration, and the basics of both space geodesy and technological navigation.
Assessment Methods and Criteria: Exam and exercises
Study Material: Partly here: https://users.aalto.fi/~mvermeer/geodesy.pdf
Substitutes for Courses:

Maa-6.1213 Johdanto geodesiaan and Maa-6.1214 Moderni geodesia
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E1010
Grading Scale: 0-5
Language of Instruction: English, may be completed in Finnish or Swedish on request

GIS-E1020 From Measurements to Maps L (5 cr)
GIS-E1020 Mittauksista kartoiksi
GIS-E1020 Från mätningar till kartor

Status of the Course: Master's Programme in Geoinformatics, common studies (compulsory)
Level of the Course: Master's level, doctoral level
Responsible teacher: Matti Vaaja
Teaching Period: I (autumn term)
Workload:
Lectures (18 h), assignments (60 h), self-study (30 h), preparation for examination + examination (27 h)
Learning Outcomes:
To be able to plan the base network hierarchy necessary for geodetic control of mapping processes. To appreciate the need for complementary terrestrial measurements to complete the raw material for mapping collected by aerial techniques, as well as produce the ground truth. To be able to, irrespective of mapping technology used, make sure that a correct, consistent and precise geodetic reference frame will be used for mapping. To understand and apply the complete photogrammetric mapping process and create input data for geoinformation systems. To understand and apply the complete laser scanning mapping process and create input data for geoinformation systems. To understand stages of the remote sensing process and create input data for geoinformation systems. To understand mapping and data policy issues. To understand digital maps: formats, standards, legend design, accessibility and delivery policies. To understand and apply scale dependent generalization of maps. To be able to place names on maps.
Content:
The course gives a theoretical and practical overview of mapping processes including establishment of the coordinate frame, data acquisition, data processing, and map design and compilation. In the process, geodetic, photogrammetric, remote sensing, and cartographic methods are applied. Mapping processes are discussed also from production economic and data policy points of view.
Assessment Methods and Criteria: Examination and assignments
Study Material: Lecture notes and additional literature
Substitutes for Courses:
Maa-57.3100 Käytännön fotogrammetria (6 op) OR Maa-6.2222 Käytännön geodesia AND Maa-6.2227 Geodesian maastoharjoitukset (4 op)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E1010
Grading Scale: 0-5
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E1030 Introduction to Spatial Methods (5 cr)
GIS-E1030 Johdanto spatiaalisiin menetelmiin
GIS-E1030 Introduction till spatiala metoder

Status of the Course: Master's Programme in Geoinformatics, common studies (compulsory)
Level of the Course: Master's level, doctoral level
Responsible teacher: Petri Rönnholm
Teaching Period: I (autumn term)
Workload:
Lectures (16 h), assignments (60 h), self-study (32 h), preparation for examination + examination (27 h)
Learning Outcomes:
To understand the spatial extensions of conventional statistical, mathematical and computational methods including the concept of spatial autocorrelation. To recognize the special requirements of geodetic, photogrammetric, remote sensing and GIS applications in spatial processing. To apply suitable spatial analysis methods in these applications. To evaluate the quality of geographical data. To be able to program simple algorithms in Matlab and R.
Content:
This course introduces various mathematical, statistical and computational methods in their spatial forms. The contents of the course cover processing, analysis and quality issues of spatial data including measures of autocorrelation, spatial statistics, convolution, spatial interpolation, data classification and clustering methods,

geometric problem solving and spatial algorithms, and quality concepts and measures.
Assessment Methods and Criteria: Examination and assignments
Study Material: Lecture notes and additional literature
Substitutes for Courses:
Maa-57.3110 Käytännön kaukokartoitus (6 op) OR Maa-123.3520 Principles of Geostatistics (3 cr) AND Maa-123.3410 Fuzzy Modeling of Geographic Information (4 cr)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E10130
Grading Scale: 0-5
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E1040 Photogrammetry, Laser Scanning and Remote Sensing L (5 cr)
GIS-E1040 Fotogrammetria, laserkeilaus ja kaukokartoitus
GIS-E1040 Fotogrammetri, laserskanning och fjärranalys

Status of the Course: Master's Programme in Geoinformatics, common studies (compulsory)
Level of the Course: Master's level, doctoral level
Responsible teacher: Matti Vaaja
Teaching Period: II (autumn term)
Workload:
Lectures (20 h), assignments (60 h), self-study (28 h), preparation to examination + examination (27 h)
Learning Outcomes:
To understand techniques and instruments of photogrammetric, laser scanning and remote sensing measurements. To understand theories of photogrammetric and laser scanning measurements.To understand the physical basics of remote sensing and be able to perform pre-processing, analysis and interpretation of remotely sensed data. To recognize alternatives and possibilities of photogrammetric, laser scanning and remote sensing applications. To understand registration and integration of data. To be able to solve casedependent surveying problems.
Content:
The course gives theoretical background on photogrammetric, laser scanning and remote sensing measurements. Measuring processes include calibration, mathematical sensor models, data pre-processing, data analysis, data integration, and visualization. In addition, the course highlights implementations of modern data acquisition instruments.
Assessment Methods and Criteria: Examination and assignments
Study Material: Lecture notes and additional literature
Substitutes for Courses:
Maa-57.3170 Lähifotogrammetria (3 op) AND Maa-57.3180 Laserkeilaus (2 op)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E1040
Prerequisites:
It is recommended (but not mandatory) to take courses GIS-E1020 From Measurements to Maps and GIS-E1030 Introduction to Spatial Methods before participating in this course.
Grading Scale: 0-5
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E1060 Spatial Analytics L (5 cr)
GIS-E1060 Spatiaalinen analytiikka
GIS-E1060 Spatial analys

Status of the Course: Master's Programme in Geoinformatics, common studies (compulsory)
Level of the Course: Master's level, doctoral level
Responsible teacher: Kirsi-Kanerva Virrantaus
Teaching Period: II (autumn term)
Workload:
Learning sessions 24 (4), Weekly assignments 48 (8), Individual study 60, Examination 3
Learning Outcomes:
After the course, you can identify appropriate analysis approaches for different geospatial tasks and describe data needs and suitable methods for the analysis process. You can carry out analysis processes using basic methods of spatio-statistical analysis, geostatistics, map algebra and geovisual analysis. You can discuss the strengths and limitations of the methods.
Content:
Processes applying statistical analysis methods for spatial point patterns and multivariate data. Kriging as an example of geostatistics. Analysis processes with map algebra using raster data layers. Use of graph analysis

methods. Interactive visual analysis with linked views of thematic maps and multivariate visualization methods. Interactive visual analysis with linked views of thematic maps and multivariate visualization techniques.
Assessment Methods and Criteria: Assignments and examination.
Study Material: Lecture notes and additional literature.
Substitutes for Courses:
Maa-123.3510 GIS Analysis and Modelling (5 cr) OR Maa-123.3530 Visual Analysis in GIS (4 cr)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E1060
Prerequisites: GIS-E1030 Introduction to Spatial Methods, or similar knowledge
Grading Scale: 0-5
Registration for Courses: Oodi
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E1070 Theories and Techniques in GIS L (5 cr)
GIS-E1070 GIS-teoriat ja -tekniikat
GIS-E1070 Teorier och teknologi i GIS
Status of the Course: Master's Programme in Geoinformatics, common studies (compulsory)
Level of the Course: Master's level, doctoral level
Responsible teacher: Jussi Nikander

Teaching Period: II (autumn semester)
Workload:
Lectures (20), assignments (50), self-study (35), preparation for examination and examination (30)
Learning Outcomes:
The student can identify the main spatial data modeling methods and their implementations. The student can understand the principles of spatial data structures and algorithms. The student can apply modeling techniques and algorithms in spatial problems. The student can evaluate the suitability of the solutions.
Content:
Spatial data modeling methods. Spatial algorithms, spatial data structures, spatial indexing methods. Introduction to programming environments for GIS. Spatial simulation methods and visualization techniques.
Assessment Methods and Criteria: Lectures, assignments and exam
Study Material: Lecture notes and additional literature
Prerequisites: GIS-E1030 Introduction to Spatial Methods
Grading Scale: 0-5
Registration for Courses: Oodi
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E3010 Least-Squares Methods in Geoscience L (5 cr)
GIS-E3010 Pienimmän neliösumman menetelmät geotieteissä
GIS-E3010 Minsta kvadraternas methoder in jordvetenskaperna

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Martin Vermeer
Teaching Period: III (spring term)
Workload:
Lectures (20 h), assignments (68 h), self-study (20 h), preparation for examination + examination (27 h)
Learning Outcomes:
To understand fundamentals of least-squares adjustment, network geometry, observation equations, linearization, datums and transformations. To be able to program (Matlab) least-squares adjustment for photogrammetric tasks: exterior orientation, relative orientation, and space intersection. To understand how the least-squares adjustment is established and solved for block adjustment and camera calibration.
To understand how least-squares adjustment is applied for positioning techniques (GNSS) as well as to understand observation geometry and dilution of precision in navigation cases. To understand least-squares collocation in gravity field modelling. To understand network quality, precision and reliability, variancecovariance matrix and precision criteria, statistical testing and hypotheses (chi-squared and data snooping), test significance and power, reliability metrics, redundancy, confidence areas or regions, and error seeking.
To understand and apply Wiener-, Kalman-, particle filters, and real-time estimation in mapping platform navigation and airborne gravimetry. To understand the theory and application of stochastic processes. To understand advanced statistical techniques as applied in geosciences, like Bayesian inference and information criteria (Akaike).

Content:
The course focuses on applying least-squares adjustment for geodetic and photogrammetric tasks. In geodesy, this aims at obtaining optimal results from network measurement, gravity field modelling and positioning, for example. In photogrammetry, a typical application is to solve the unknown model parameters of imaging geometries, such as interior and exterior orientation, instrument calibration, space intersection, aerial triangulation, and feature extraction.
Assessment Methods and Criteria: Examination and exercises
Study Material: Lecture notes and additional literature
Substitutes for Courses: Maa-57.3120 Analyyttinen fotogrammetria (4 op)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E3010
Prerequisites: Basic statistics and probability
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi
Further Information: From teachers: Martin Vermeer, Petri Rönnholm, Ulla Kallio

GIS-E3020 Digital Image Processing and Feature Extraction L (5 cr)
GIS-E3020 Digitaalinen kuvankäsittely ja piirteiden irrotus
GIS-E3020 Digital bildbehandling och egenskapsextraktion

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Petri Rönnholm
Teaching Period: III (spring term)
Workload:
Lectures (20 h), assignments (50 h), self-study (38 h), preparation for examination + examination (27 h)
Learning Outcomes:
To understand principles of sampling and reconstruction of a signal. To understand and apply Fourier transformation of images. To understand and apply linear space-invariant systems with images. To understand and apply basic digital image processing tasks, such as image restoration, image enhancement, image compression, and image correlation. To understand and apply how edges and interesting points can be extracted from images. To understand segmentation of digital images.
Content:
The course gives fundamentals of signal processing focusing on digital images. Mathematical principles of image enhancing and restoration are given. The course also illustrates how areas, breaklines and interesting points, such as corners and centers of circles, can be extracted automatically from images.
Assessment Methods and Criteria: Examination and assignments
Study Material: Lecture notes and additional literature
Substitutes for Courses: Maa-57.3130 Digitaalinen fotogrammetria I (4 op)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E3020
Grading Scale: 0-5
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E3030 Advanced Laser Scanning L (5 cr)
GIS-E3030 Laserkeilauksen syventävä kurssi
GIS-E3030 Avancerad laserskanning

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Hannu Hyyppä

Teaching Period: IV (spring term)
Workload:
Lectures (20 h), assignments (60 h), self-study (28 h), preparation for examination + examination (27 h)
Learning Outcomes:
To understand special applications of laser scanning. To understand mobile, UAV and multi-/hyperspectral laser scanning. To understand and apply processing algorithms of 3D point clouds. To understand and apply registration and integration of laser scanning data with other data sources.
Content:
This course gives a deeper insight on laser scanning methods such as the use of mobile laser scanning, UAV laser scanners, multi- and hyperspectral laser scanning, handheld scanners, and special applications of laser scanning. In addition, algorithms of 3D data processing and integration with other data sources are emphasized. The course includes also a seminar part in which the recent development of laser scanning is

illustrated.
Assessment Methods and Criteria: Examination and assignments
Study Material: Lecture notes and additional literature
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E3030
Prerequisites:
It is recommended (but not mandatory) to take courses GIS-E1020 From Measurements to Maps and GIS-E1040 Photogrammetry, Laser Scanning and Remote Sensing before participating in this course.
Grading Scale: 0-5
Language of Instruction:
English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi**GIS-E3040 Advanced Photogrammetry L (5 cr)**

GIS-E3040: Advanced Photogrammetry
GIS-E3040 Fotogrammetrian syventävä kurssi
GIS-E3040 Avancerad fotogrammetri

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Petri Rönnholm

Teaching Period: IV (spring term)
Workload: Lectures (18 h), assignments (60 h), self-study (30 h), preparation for examination + examination (27 h)
Learning Outcomes:
To understand and apply homogeneous coordinates and projective geometry for solving the main tasks of photogrammetry. To understand Structure-from-Motion and Dense Matching. To understand dynamic applications of photogrammetry. To understand Optical Flow, tracking of moving objects and image-based navigation. To recognize industrial applications of photogrammetry.
Content:
This course gives a computer vision perspective on solving main tasks in photogrammetry, especially by applying homogeneous coordinates and projective geometry. The contents highlight possibilities of automation in photogrammetry by utilizing latest algorithms to find orientations of images and to create photogrammetric 3D point clouds. The course includes also a seminar part in which the recent developments of photogrammetry and computer vision are illustrated.
Assessment Methods and Criteria: Examination, seminar and assignments
Study Material: Lecture notes and additional literature
Substitutes for Courses: Maa-57.3140 Analyyttinen Fotogrammetria II (4 op) OR Maa-57.3150 Digitaalinen fotogrammetria II (4 op)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E3040
Prerequisites:
It is recommended (but not mandatory) to take courses GIS-E1020 From Measurements to Maps, GIS-E1040 Photogrammetry, Laser Scanning and Remote Sensing, GIS-E3010 Least-Squares Methods in Geoscience and GIS-E3020 Digital Image Processing and Feature Extraction before participating in this course.
Grading Scale: 0-5
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E3050 Advanced Remote Sensing L (5 cr)
GIS-E3050 Kaukokartoituksen syventävä kurssi
GIS-E3050 Avancerad fjärranalys

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Miina Rautiainen

Teaching Period: V
Workload:
Lectures 16 h, assignments and seminar presentation 85 h, independent study 30 h, exam 2 h
Learning Outcomes:
To understand the physical principles of optical remote sensing and to evaluate remote sensing methods based on them. To be able to describe the remote sensing process through physically-based reflectance modeling.To be able apply hyper- and multispectral data in environmental monitoring. To be familiar with global satellitebased products and their development. To be able to develop remote sensing methods to monitor the global environment and climate change. To be familiar with upcoming trends in Earth observation.

Content:
The course provides a deep insight to modern optical remote sensing and its applications in global monitoring of the environment and climate. The course covers hyperspectral and multispectral remote sensing techniques, physical modeling and global remote sensing methods.
Assessment Methods and Criteria:
The course is composed of lectures, assignments and a seminar. The students' performance is assessed based on assignments, seminar presentations and an exam. **All students must be present in the first lecture.**
Study Material: Will be announced at the beginning of the course.
Substitutes for Courses:
Maa-57.3210 Kaukokartoitusaineiston luokittelu ja mallintaminen (4 op) and Maa-57.3200 Tutkakuvat kaukokartoituksessa (3 op)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E3050
Prerequisites:
GIS-E1040 Photogrammetry, laser scanning and remote sensing OR ELEC-4510 Earth observation, OR similar knowledge and skills.
Grading Scale: 0-5
Registration for Courses: WebOodi
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E4020 Advanced Spatial Analytics L (5 cr)
GIS-E4020 Spatiaalianalytiikan syventävä kurssi
GIS-E4020 Avancerad spatial analys

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Kirsi-Kanerva Virrantaus
Teaching Period: III-IV (spring term)
Workload:
Learning sessions (24), assignments (20), project work (50), self-work and preparation for exam (38), exam (3)
Learning Outcomes:
After the course, you can identify the contributions of recent research in spatial data mining and geospatial simulation. You can carry out spatial knowledge discovery by using both computational and visual data mining methods to spatial problems. You can discuss the strengths and limitations of the methods.
Content:
Spatial data mining methods for various types of spatial data sets: points, polygon networks, gridded data and networks. Advanced spatial classification and clustering methods, spatial association rules, graph data mining including moving objects data sets. Introduction to geospatial simulation and fuzzy modeling. Assignments, examination.
Assessment Methods and Criteria: Examination, assignments and project work.
Study Material: Lecture notes and additional literature
Substitutes for Courses: Maa-123.3585 Spatial Data Mining
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E4020
Prerequisites:
GIS-E1030 Introduction to Spatial Methods, GIS-E1060 Spatial Analytics and GIS-E1070 Theories and techniques in GIS.
Grading Scale: 0-5
Registration for Courses: **Web**Oodi
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E4030 GIS Development L (5 cr)
GIS-E4030 GIS kehitys
GIS-E4030 GIS utveckling

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Jussi Nikander
Teaching Period: V (spring semester)
Workload:
Lectures (24), assignments (50), self-study and preparation for exam (58), exam (3)
Learning Outcomes:
The student can describe the process of software engineering and software development project. The student

understands the architecture and design of distributed GIS. The student can apply programming for geocomputation and implement spatial databases. The student can analyse the suitability of geospatial software and GIS for a given problem.
Content:
GIS application development as a project. Software engineering approaches and methods. Advanced programming in GIS. Geographical data base management systems and GIS architectures. Spatial data privacy and security issues.
Assessment Methods and Criteria: Examination and assignments
Study Material: Lecture notes and additional literature
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E4030
Prerequisites: GIS-E1070 Theories and techniques in GIS
Grading Scale: 0-5
Registration for Courses: Oodi
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

GIS-E5030 Physical Geodesy L (5 cr)
GIS-E5030 Fysikaalinen geodesia
GIS-E5030 Fysikalisk Geodesi

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Martin Vermeer
Teaching Period: V (spring term)
Workload:
Lectures (24 h), assignments (60 h), self-study (31 h), preparation for examination + examination (20 h)
Learning Outcomes:
To compute the gravitational field of a simple object. To do simple computations on gravity anomalies and the terrain correction. To convert between geopotential numbers, orthometric and normal heights. To do simple computations relating to isostatic compensation. To statistically predict gravity anomalies using collocation. To understand the expression of the Earth's gravity field in spherical harmonic coefficients and the spectral behaviour of gravity anomalies and geoid heights. To understand the basics of gravimetric geoid determination.
Content:
The Earth's gravity field and its representations; the geopotential and spherical harmonic expansions; different observation types and their processing; gravity anomalies; the figure of the Earth (geoid) and its determination; height measurement and height systems; terrain models and terrain effects; gravity and the internal structure of the Earth; sea level, the geoid and sea surface topography; the use of satellites in determining the gravity field.
Assessment Methods and Criteria: Computing exercises and exam
Study Material: https://users.aalto.fi/~mvermeer/fys-en.pdf
Substitutes for Courses: Maa-6.3272 Avaruusgeodesia (4 op) TAI Maa-6.3273 Physical Geodesy
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E5030
Prerequisites: GIS-E1010 Geodesy and Positioning
Grading Scale: 0-5
Language of Instruction: English, may be completed in Finnish or Swedish on request

GIS-E5040 Mathematical Geodesy L (5 cr)
GIS-E5040 Matemaattinen Geodesia
GIS-E5040 Matematisk Geodesi

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teacher: Martin Vermeer
Teaching Period: IV (spring term)
Workload:
Lectures (24 h), assignments (68 h), self-study (23 h), preparation for examination + examination (20 h)
Learning Outcomes:
To do simple computations on the sphere and understands the geometry of the reference ellipsoid. To solve,

To do simple computations on the sphere and understands the geometry of the reference ellipsoid. To solve,

using tools like Matlab, the geodetic forward and inverse problems etc. on the reference ellipsoid. To basically grasp global and local reference systems and execute transformations between them. To basically grasp Gaussian and Riemannian surface theories and derive the metric tensor, Christoffel symbols and curvature tensor for simple surfaces. To understand the basic math of map projections, especially conformal ones, and the behaviour of map scale, and to compute the isometric latitude. To be aware of the reference systems and map projections used in Finland and able to use them.
Content:
Spherical trigonometry, geodetic co-ordinate computations in ellipsoidal and rectangular spatial co-ordinate systems, astronomical co-ordinates, co-ordinate system transformations, satellite orbits and computations, Gaussian and Riemannian surface theories, map projection computations, reference systems and map projections in use in Finland.
Assessment Methods and Criteria: Exam and exercises
Study Material: Announced separately
Substitutes for Courses:
Maa-6.3289 GNSS-technologies OR Maa-6.3287 Mathematical Geodesy OR GIS-E5020 GNSS-technologies
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E5040
Prerequisites: GIS-E1010 Geodesy and Positioning
Grading Scale: 0-5
Language of Instruction: English, may be completed in Finnish or Swedish on request

GIS-E6010 Project Course L, V(V) (10 cr)
GIS-E6010 Projektityökurssi
GIS-E6010 Projektkurs

Status of the Course: Master's Programme in Geoinformatics, advanced studies (optional)
Level of the Course: Master's level, doctoral level
Responsible teachers: Petri Rönnholm; Matti Vaaja; Miina Rautiainen; Pirjo Ståhle; Martin Vermeer; Kirsi Virrantaus
Teaching Period: I-II (autumn term), 2nd year
Workload: Project work (270 h)
Learning Outcomes:
To be able to develop or apply concepts, processes, systems, software, instruments or algorithms of the selected field of focus. To be able to write scientific or technical report of outcomes.
Content:
This course emphasizes how theoretical and practical background can be transformed into larger workflows, customized applications or system/software development. Tasks are related to real-world problems and formulated in collaboration with working life. Students can choose in which field they focus: geodesy, navigation, photogrammetry, laser scanning, remote sensing, GIS, or cartography.
Substitutes for Courses:
Maa-57.3160 Digitaalinen fotogrammetria III (2 cr) and Maa-57.3220 Kaukokartoituksen projektityö (9 cr) or Maa-123.3550 GIS Application development (8 cr) and literature (2 cr) or Maa-6.3255 Seminar on Geodesy, Navigation and Positioning (3-6 cr) and Maa-6.3261 Engineering Geodesy (5 cr) or Maa-6.3288 GIS and Geodetic Measurements (5 cr)
Course Homepage: https://mycourses.aalto.fi/course/search.php?search=GIS-E6010
Prerequisites:
GIS-E1020 From Measurements to Maps, GIS-E1010 Geodesy and Positioning, GIS-E1030 Introduction to Spatial Methods, GIS-E1040 Photogrammetry, Laser Scanning and Remote Sensing, GIS-E1060 Spatial Analytics, GISE1050 Visualization of Geographical Information (or similar knowledge corresponding to the contents of these six courses).
Grading Scale: 0-5
Language of Instruction: English, suoritettavissa pyydettäessä suomeksi tai ruotsiksi

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GIS-L8010 Research Seminar in Geoinformatics L, V(V) (1-10 cr)

Responsible teachers: Hannu Hyyppä; Petri Rönnholm; Matti Vaaja; Martin Vermeer; Kirsi Virrantaus; Miina Rautiainen
Status of the Course: Doctoral studies
Level of the Course: Doctoral level
Teaching Period: I,II,III,IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:

After the course the student has deepened his/her scientific understanding of topical issues in geoinformatics. The student will be more familiar with various research methods and data types, and their suitability to different topics in geoinformatics.
Content:
To be agreed with professor.
Assessment Methods and Criteria:
To be agreed with professor.
Course Homepage: None
Grading Scale: 0-5 or pass/fail
Registration for Courses:
The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinfomatics.

GIS-L8020 Scientific Practices and Principles in Geoinformatics L, V(V) (1-10 cr)

Responsible teachers: Petri Rönnholm; Miina Rautiainen; Matti Vaaja; Martin Vermeer; Kirsi Virrantaus; Hannu Hyyppä
Status of the Course: Doctoral studies
Level of the Course: Doctoral level
Teaching Period: I, II, III, IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:
After the course student has deepened his/her scientific understanding of scientific practices and principles in geoinformatics.
Content: The content is tailored to fit the student's doctoral study plan.
Assessment Methods and Criteria: To be agreed with professor.
Grading Scale: 0-5 or pass/fail
Registration for Courses: The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinfomatics.

GIS-L8030 Doctoral Studies in Photogrammetry L, V(V) (1-10 cr)
Responsible teacher: Petri Rönnholm; Matti Vaaja
Status of the Course: Doctoral studies
Level of the Course: Doctoral level
Teaching Period: I,II,III,IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:
After the course the student has deepened his/her scientific understanding of photogrammetry topics and practices.
Content: The content is tailored to fit the student's doctoral study plan.
Assessment Methods and Criteria: To be agreed with professor.
Course Homepage: None
Grading Scale: 0-5 or pass/fail
Registration for Courses: The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinformatics..

GIS-L8040 Doctoral Studies in Remote Sensing L, V(V) (1-10 cr)

Responsible teacher: Miina Rautiainen
Status of the Course: Doctoral studies
Level of the Course: Doctoral level
Teaching Period: I,II,III,IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:
After the course the student has deepened his/her scientific understanding of geoinformation technology topics and practices.
Content: The content is tailored to fit the student's doctoral study plan.
Assessment Methods and Criteria: To be agreed with professor.

Course Homepage: None
Grading Scale: 0-5 or pass/fail
Registration for Courses: The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinfomatics.

GIS-L8050 Doctoral Studies in Laser Scanning L, V(V) (1-10 cr)

Responsible teachers: Matti Vaaja; Petri Rönnholm; Hannu Hyyppä
Status of the Course: Doctoral studies
Level of the Course: Doctoral level
Teaching Period: I,II,III,IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:
After the course the student has deepened his/her scientific understanding of laser scanning topics and practices.
Content: The content is tailored to fit the student's doctoral study plan.
Assessment Methods and Criteria: To be agreed with professor.
Course Homepage: None
Grading Scale: 0-5 or pass/fail
Registration for Courses: The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinfomatics.

GIS-L8060 Doctoral Studies in Geodesy and Navigation L, V(V) (1-10 cr)

Responsible teacher: Martin Vermeer
Status of the Course: Doctoral studies
Level of the Course: Doctoral level
Teaching Period: I,II,III,IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:
After the course the student has deepened his/her scientific understanding of geodesy and navigation topics and practices.
Content: The content is tailored to fit the student's doctoral study plan.
Assessment Methods and Criteria: To be agreed with professor.
Course Homepage: None
Grading Scale: 0-5 or pass/fail
Registration for Courses: The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinfomatics.

GIS-L8070 Doctoral Studies in Geoinformation Technology L, V(V) (1-10 cr)

Responsible teacher: Kirsi Virrantaus
Status of the Course: Doctoral studies
Level of the Course: Doctoral level
Teaching Period: I,II,III,IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:
After the course the student has deepened his/her scientific understanding of geoinformation technology topics and practices.
Assessment Methods and Criteria: To be agreed with professor.
Course Homepage: None
Grading Scale: 0-5 or pass/fail
Registration for Courses: The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinfomatics.

GIS-L8080 Doctoral Studies in Cartography L, V(V) (1-10 cr)

Responsible teacher: Kirsi Virrantaus
Status of the Course: Doctoral studies

Level of the Course: Doctoral level
Teaching Period: I,II,III,IV or V (autumn or spring term)
Workload: To be agreed with professor.
Learning Outcomes:
After the course the student has deepened his/her scientific understanding of cartography topics and practices.
Content: The content is tailored to fit the student's doctoral study plan.
Assessment Methods and Criteria: To be agreed with professor.
Course Homepage: None
Grading Scale: 0-5 or pass/fail
Registration for Courses: The course is offered only to doctoral students in Geoinfomatics.
Language of Instruction: English
Further Information: The course is offered only to doctoral students in Geoinfomatics.