



# Doctoral programme — Geodesy and Geoinformatics

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*The programme description was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.*

## Programme description (KTHGEO)

### Programme name

Geodesy and Geoinformatics (Geodesi och Geoinformatik)

### Subject area

In geodesy and geoinformatics, spatial information is collected and analyzed.

Geodesy (from the Greek geodaisia, division of land) is one of the oldest natural sciences. Geodesy studies spatial relationships on and near the Earth's surface for mapping, urban planning, engineering design and other scientific studies, as well as the Earth's gravity field and its shape, including the so-called geoid. Geodesy utilizes many different methods of measurement, calculation and visualization, based on mathematical, statistical and physical theories. Satellite-based methods such as GPS and satellite gravimetry are becoming increasingly important.

Geoinformatics is the science and technology for acquisition, management, analysis and presentation of geospatial data and information about objects, phenomena and processes on and around the Earth, such natural and built environment, their current state and undergoing changes. Geoinformatics includes remote sensing, cartography and GIS.

### The doctoral programme's overall purpose and learning outcomes

The goal for the doctoral programme is that students will become independent, critical and creative scientists. The education will provide skills in scientific methods of high relevance to each subject area as well as advanced knowledge in specific areas.

The programme will prepare students for professional activities in the field chosen. Active participation is pursued in national and international research networks within the area in question.

Doctoral studies shall provide students with a good overview of the area and sound theoretical and methodological training. The main objective of the education is to provide a basis for further independent activities as researchers, analysts or teachers. It also aims to provide the students the ability to take part in interdisciplinary cooperation.

The overall goals for doctoral studies in the subject of Geodesy and geoinformatics are consistent with the objectives agreed for KTH doctoral studies 2009-02- 24, which are described below.

The purpose of KTH doctoral studies is to provide society with competent researchers who can contribute to its sustainable development.

The goal of KTH doctoral studies is for doctoral students to become independent and excellent researchers. After completing their studies, doctoral students will be able to:

- describe and explain theories and empirical results in the field in question
- formulate specific research issues in the field in question
- use scientific method and develop new knowledge through their own scientific studies

- critically analyze and evaluate the methods and results from own and others' scientific studies
- present and discuss research findings in the scientific community
- present research in an educational way outside the scientific community and in educational contexts
- assess the ethical aspects of research within the field in question and act on these
- identify needs for new knowledge, and understand how to initiate and direct research projects

Education at doctoral level shall also strive to ensure that students after graduation are able to:

- participate in interdisciplinary collaboration within the relevant field
- analyze the role of research in sustainable development.

*These goals expired 2014-12-09 according to the Rector's decision, reference number V-2014-0374. As before, the objectives of the education at graduate level are consistent with the objectives specified for the doctoral degree in the Higher Education Ordinance, Appendix 2 Degree Ordinance.*

## **The doctoral programme's size and recruitment**

The doctoral programme intends to continuously train at least 15 doctoral students. The size of the programme is set to at least 15 students, which corresponds to an admission of at least 3 students / year.

The target group for this programme is students from the master programme of Transport and Geoinformation Technology (TTGTM) or equivalent.

Doctoral students are recruited through advertising of doctoral positions, recruiting from other types of employment or through assessment of admission requirements of students who have received an externally financed scholarship.

There are eight qualified supervisors.

## **Funding**

The doctoral programme, including its quality enhancement activities and doctoral student positions, is funded through a combination of internal and external research funding (from research councils, government agencies and industry) as well as external scholarships.

## **Courses**

The courses within the doctoral programme are all offered within a third-cycle subject and are therefore presented in the study plan for the subject.

## **Quality enhancement activities**

Journals' peer-review process is central to quality enhancement and sets the "bar" for the doctoral students. The publishing norm for a compilation thesis in geodesy is 4-6 articles, of which at least two shall be published and the rest to be peer reviewed for publication in an international journal. For monographs, the "bar" is set to at least one published article. The minimum requirement for licentiate degree is half of that of a doctoral degree, i.e. at least two good articles for a compilation thesis and at least one nationally published / approved article for a monograph thesis.

Publishing norm for a PhD thesis in Geoinformatics is 4-6 articles, of which at least two shall be published and the rest to be peer reviewed for publication in an international journal. For monographs, the "bar" is set at least one published article. For licentiate degree, the minimum requirement is half of that of a doctoral degree, i.e. at least two good articles for a compilation thesis and at least one nationally published / approved article for a monograph thesis.

The systematic quality enhancement also includes ongoing seminar discussions, and consultation between the students and the supervisors are also important.

Each doctoral student should have at least two supervisors, one of whom is the main supervisor and at least one of the two supervisors must have undergone KTH's supervisor training or equivalent education.

## National and international network

Both Geodesy and Geoinformatics have a large network of contacts with other universities, research groups, organisations and associations, both national and international.

The above is enumerated and defined in appendix 3.

## Further instructions for registration

### Geodesy

#### *International networks:*

- A Nordic post graduate summer school in geodesy is held every four years. The research groups in the Nordic countries takes turn in hosting it. Sweden will host the school of 2016.
- An international, itinerant school in the field of physical geodesy has been established under the leadership of the KTH geodesy group.
- The group has established the international journal Journal of Geodetic Science (<http://versita.com/science/geoscience/jgs/>) with more than 15 scientific advisors and more than 20 editors worldwide.
- ESA / JRC International Summer School on GNSS is held annually with students participating from all over Europe.
- The International Association of Geodesy (IAG), the International Federation of Surveyors (FIG), and the European Geosciences Union (EGU) often organise events for doctoral students in geodesy.

Many research projects are part of collaborations with international partners; universities and organisations, which varies from project to project.

#### *National networks:*

- Swedish National Committee for Geophysics [Geodesy: KTH, CTH (Onsala), Lantmäteriet]
- Utbildningsrådet för Landskapsinformation (the education council for geographic information), called ULI-Geoforum
- Onsala Space Observatory at Chalmers University of Technology
- The Swedish Radio Navigation Board
- Swedish Space Center

Some research projects are part of collaborations with external national partners, which varies from project to project.

### Geoinformatics

#### *International networks:*

- IEEE Geoscience and Remote Sensing Society (GRSS)
- International Society for photogrammetry and Remote Sensing (ISPRS)
- International Cartographic Association (ICA)
- European Association of Remote Sensing Laboratories (EARSeL)
- The Association of Geographic Information Laboratories in Europe (AGILE)
- Group on Earth Observations (GEO), the SB-02 Global Land Cover, SB-04 Global Urban Observatory and Information, and Global Human Settlement Working Group
- European Space Agency, the Canadian Space Agency, the German Aerospace Center, NASA, the Chinese Ministry of Science and Technology, etc.

#### *National networks:*

ULI Geoforum is a national association in the field of geographic information and geographic IT with over 200 member organisations.

The Cartographic Society is probably the oldest society in the field. The society wants to increase the interest in Swedish map production in the areas of photogrammetry, remote sensing, geodesy, GIS, geographic IT, historical cartography and cartography. The Society also wants to promote the development and the knowledge within these areas in Sweden.

## Appendixes

Appendix 1: Study plan for third-cycle subject Geodesy and Geoinformatics (GEODEINF).

Appendix 2: List containing names and subject areas of supervisors within the programme

Appendix 3: Presentation of the programme's national and international network



# Doctoral programme — Geodesy and Geoinformatics

## Appendix 1: Study plan for third-cycle subject Geodesy and Geoinformatics (GEODEINF).

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*The subject plan was approved by Fakultetsnämnden (Faculty Board) November 30, 2010. Valid from Spring 11.*

### Subject title

Geodesy and Geoinformatics (Geodesi och Geoinformatik)

### Subject description and programme outcomes

#### Scientific field

In geodesy and geoinformatics, spatial information is collected and analyzed. The third-cycle subject has two specialisations; geodesy and geoinformatics.

Geodesy (from the Greek geodaisia, division of land) is one of the oldest natural sciences. Geodesy studies spatial relationships on and near the Earth's surface for mapping, urban planning, engineering design and other scientific studies, as well as the Earth's gravity field and its shape, including the so-called geoid. Geodesy utilizes many different methods of measurement, calculation and visualization, based on mathematical, statistical and physical theories. Satellite-based methods such as GPS and satellite gravimetry are becoming increasingly important.

Geoinformatics is the science and technology for acquisition, management, analysis and presentation of geospatial data and information about objects, phenomena and processes on and around the Earth, such natural and built environment, their current state and undergoing changes. Geoinformatics includes remote sensing, cartography and GIS.

#### Description of possible specialisation

1. Common for all specialisations
2. Geodesy
3. Geoinformatics

#### Specification of how the programme outcomes are to be achieved

The goals of the education are achieved through courses according to the individual study plan, seminar participation, participation in national and international conferences as well as through supervision.

### Common for all specialisations

#### Description of the specialisation

The information given is common information for all specialisations.

#### Current research

See each specialisation.

## **Programme structure**

Doctoral studies consist of coursework and a thesis/dissertation part. Coursework may be in the form of lectures, literature studies and problem-solving, as well as active participation in seminars and conferences. Courses can be studied within the department or in collaboration with other Swedish or foreign research institutions.

Doctoral studies are conducted under the direction of a main supervisor, along with at least one assistant supervisor, according to the individual study plan. Students' individual study plans will be adapted to their prior knowledge and to the contents of the dissertation/thesis. Doctoral students' progress will be assessed at least once a year in connection with the review of the individual study plan and this will be carried out by the student and the main supervisor. The study plan is ratified by the Director of Third Cycle Education.

A licentiate degree may be taken as part of a doctor's degree. Courses and dissertation work included in the licentiate degree may also be credited for a doctor's degree.

A licentiate degree consists of coursework of 45-60 ECTS and a dissertation of 60-75 ECTS, totalling 120 ECTS. A doctor's degree consists of coursework of 75 ECTS (Geodesy) / 60 ECTS (Geoinformatics) and a thesis of 165 ECTS (Geodesy), 180 ECTS (Geoinformatics), totaling 240 ECTS.

## **Seminars and conferences**

The programme includes active participation in research seminars at the department, during which students regularly submit their own texts. Students must also participate in national and international conferences and research networks within the relevant fields.

## **Compulsory and recommended courses**

Courses will be studied in accordance with the agreement made between the student and the main supervisor in the individual study plan.

Doctoral students who teach at first or second cycle must have completed initial university teacher training.

The programme has two specialisations: geodesy and geoinformatics. Course work for a doctor's degree comprises of 75 ECTS for the geodesy specialisation and 60 ECTS for the geoinformatics specialisation. Courses within the chosen area of specialisation must amount to at least 37.5 ECTS. Coursework for a licentiate degree comprises 45 ECTS for both specialisations.

Percentage of courses that can be taken at the first cycle and second cycle is regulated by KTH's local policy.

Compulsory courses (7.5 credits each) for the Geodesy specialisation is Theory of Science and Research Method, FAG5129 Theory of Errors and FAG5130 Satellite-based Positioning.

Compulsory courses for the Geoinformatics specialisation is Theory of Science and Research Method, 1E5520 Visualization of Geoinformation and 1E5510 Knowledge-based Remote Sensing.

## **Thesis**

Dissertation/thesis work is an obligatory part of doctoral studies. This part of the programme aims at the student developing the ability to make independent contributions to research and a capacity for scientific cooperation, within and outside their own subject. The dissertation/thesis shall contain new research results that the student has developed, alone or in cooperation with others. The main scientific results should meet the quality requirements for publication in internationally recognized journals with peer review. A doctoral student's contribution to a dissertation/thesis text that has multiple authors must be distinguishable.

Dissertations and theses must be written in English. They can be either a monograph or a collection of scientific articles, together with a special written summary. A doctoral thesis is normally based on the licentiate thesis.

# Geodesy

## Description of the specialisation

Geodesy (from the Greek geodaisia, division of land) is one of the oldest natural sciences. Geodesy studies spatial relationships on and near the Earth's surface for mapping, urban planning, engineering design and other scientific studies, as well as the Earth's gravity field and its shape, including the so-called geoid. Geodesy utilizes many different methods of measurement, calculation and visualization, based on mathematical, statistical and physical theories. Satellite-based methods such as GPS and satellite gravimetry are becoming increasingly important.

## Current research

The subject of geodesy is in itself quite wide, and this is reflected in the research conducted in the Division of Geodesy and Satellite Positioning.

Current research is in geoid modeling, modeling of the Earth's mass structure, satellite gravimetry, sea level change, movement of tectonic plates, design of networks for deformation surveillance and / or detection, methods for coordinate transformations, GNSS-based positioning and navigation, multi-GNSS, atmospheric effects on GNSS satellite signals, laser scanning, measurement science, theory of errors, and the integration of GNSS and terrestrial surveying technologies.

## Programme structure

*See Common for all specialisations.*

## Compulsory and recommended courses

The coursework includes 75 ECTS, of which courses within the chosen area of specialisation must amount to at least 37.5 ECTS. A licentiate degree has a course component of 45 ECTS.

The compulsory courses for the doctoral degree adds up to 22.5 ECTS.

The licentiate degree requires the course Theory of Science and Research Method, as well as one other compulsory course for the specialisation.

The optional courses should primarily be selected among the courses listed as recommended, according to the list below. Furthermore, it is desirable that at least one course from the specialisation Geoinformatics is included in the training.

### Compulsory courses

- AG5130 Satellite Based Positioning 7.5 hp.
- AG5129 Theory of Errors 7.5 hp.
- 1N5113 Theory of Science and Research Method, Technological and Natural Sciences 7.5 hp.

### Recommended courses

- AG5128 Advanced Topics in Geodesy 15.0 hp.
- AG5126 Advanced Theory of Errors 7.5 hp.
- 1E5007 Physical Geodesy 7.5 hp.
- AG5131 Inertial Navigation and Kalman Filtering 7.5 hp.
- 1E5008 Physical Geodesy, Advanced Course 15.0 hp.
- AG5123 Atmospheric Effects on GNSS Signals 7.5 hp.
- AG5124 Net Optimization and Deformation Monitoring 7.5 hp.
- AG5127 Satellite Gravimetry 7.5 hp.
- AG5125 Geodynamics 7.5 hp.

## Thesis

*See Common for all specialisations.*

## Geoinformatics

### Description of the specialisation

Geoinformatics is the science and technology for acquisition, management, analysis and presentation of geospatial data and information about objects, phenomena and processes on and around the Earth, such natural and built environment, their current state and undergoing changes. Geoinformatics includes remote sensing, cartography and GIS.

### Current research

For current research, please refer to the website <https://www.kth.se/en/abe/inst/som/avdelningar/gis/research-1.585264>

### Programme structure

*See Common for all specialisations.*

### Compulsory and recommended courses

The coursework for doctoral studies comprises of 60 ECTS and the coursework for a licentiate degree comprises of 45 ECTS.

For a doctoral degree, the compulsory courses comprising of 22.5 ECTS as described below, are required.

For the licentiate degree the requirements are; Theory of Science and Research Method, as well as one of the other obligatory courses for specialisation.

The optional courses should primarily be selected among the courses listed as recommended, according to the list below. Furthermore, it is desirable that at least one course from the specialisation Geodesy is included in the training.

Literature is ratified by the supervisor in consultation with the student. Literature in the dissertation/thesis area can be partially or completely replaced by literature in geoinformatics that contributes to the student's general orientation and methodological expertise.

#### Compulsory in-depth courses

- 1E5510 Knowledge-based Methods in Remote Sensing 7.5 hp.
- 1E5520 Visualization of Geoinformation 7.5 hp.

#### Compulsory research proficiency courses

- 1N5113 Theory of Science and Research Method, Technological and Natural Sciences 7.5 hp.

#### Recommended courses

- AG3101 Seminar on Geographic Information Science 7.5 hp.
- AG3100 Seminar on Advanced Remote Sensing 7.5 hp.

#### Recommended in-depth courses

- AG3103 Network Analysis 7.5 hp.
- AG2426 Mobile GIS 7.5 hp. Second-cycle course
- 1E5570 Active Remote Sensing Systems 7.5 hp. ,
- AG2415 Web-GIS 7.5 hp. Second-cycle course
- AG3104 Spatial Data Mining 7.5 hp.
- AG3102 Computational Methods and Algorithms in GIS 7.5 hp.
- 1E5580 Spatial Analysis 7.5 hp.
- AG5130 Satellite Based Positioning 7.5 hp.



- AG2425 Spatial Databases 7.5 hp. Second-cycle course

## **Thesis**

*See Common for all specialisations.*

## **Entry requirements and selection**

### **General and special admission requirements and prior knowledge**

The KTH general eligibility requirements for admission to doctoral studies apply.

Doctoral students are expected to read and write scientific English and speak English fluently.

### **Selection rules and procedures**

Admission to studies at the doctoral level is decided by the Dean after preparation by the programme council of the doctoral programme of geodesy and geoinformatics and the proposed main supervisor.

In addition, selection assesses the degree of maturity and capacity for independent judgement and critical analysis, as well as written scientific presentation, which forms the basis of the admissions decision and the selection of applicants. Of great significance in this assessment are previous study results in advanced courses at undergraduate level and independently conducted scientific studies. Selection of applicants for doctoral studies is carried out by the programme board in connection with admission.

## **The programme's degrees and examinations**

### **Degree of Licentiate and Degree of Doctor (PhD)**

A licentiate degree consists of coursework of 45-60 ECTS and a dissertation of 60-75 ECTS, totalling 120 ECTS. A doctor's degree consists of coursework of 75 ECTS (Geodesy) / 60 ECTS (Geoinformatics) and a thesis of 165 ECTS (Geodesy), 180 ECTS (Geoinformatics), giving a total of 240 ECTS.

### **The programme's examinations**

Doctoral courses include examinations, which may be written or oral. Examinations shall be designed so that examiners can be satisfied that the student has assimilated the full course content.



# Doctoral programme — Geodesy and Geoinformatics

## Appendix 2: List containing names and subject areas of supervisors within the programme

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A. Jensen (geodesy)

M. Horemuz (geodesy)

M. Eshagh (geodesy)

M. Baherbandi (geodesy)

Y Ban (geoinformatics)

A Östman (geoinformatics)

B Jiang (geoinformatics)

T. Shirabe (geoinformatics)



# Doctoral programme — Geodesy and Geoinformatics

## Appendix 3: Presentation of the programme's national and international network

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### **Geodesy**

#### ***International networks:***

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- International Cartographic Association (ICA)
- European Association of Remote Sensing Laboratories (EARSel)
- The Association of Geographic Information Laboratories in Europe (AGILE)
- Group on Earth Observations (GEO), the SB-02 Global Land Cover, SB-04 Global Urban Observatory and Information, and Global Human Settlement Working Group
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