ITC Study guide 2008/2009

Master Degree Course in Geoinformatics

ITC Study Guide

Geoinformatics
Master Degree Course

2008 / 2009

Contents

Course Code: C08-GFM-M-01

Foreword

Dear course participants,

Welcome to ITC.

Having left your family and country, you have come to ITC to further your education. We hope that the course you have selected will fulfil your expectations.

Education at ITC is characterised by:

- a modular set-up,
- a mixture of theory and practice, often including participants' own experiences
- a core curriculum for Remote Sensing (RS) and Geo-information Systems (GIS), common to all programmes, and
- choice options according to individual (research) interest and/or the needs of your own organisation.

We are pleased to present you this study guide for the 2008/2009 courses offered full-time at ITC Enschede. This study guide gives you information on the courses, an overview of the modules and the detailed content of the course modules. ITC is continuously modifying its courses to the needs of its students and their organisations. The structure of the MSc courses was adjusted last year in order to strengthen the links between the courses and the research projects, implemented by ITC.

Description of all elements of education at ITC and the descriptions of the modules of other courses are available on the ITC website (http://www.itc.nl/education/courses/modules.aspx).

But there is more to life at ITC than only education. You have arrived at an institute with more than 400 students from over 70 countries. Furthermore, also the ITC staff is originating from more than 30 countries: a truly international environment where you will be able to meet colleagues from all over the world. ITC is organising all sorts of social, cultural and sports activities. Well-known are the International Sports Tournament, the International Food Festival and the International Cultural Event. We would like to encourage you to participate in many if not all of these events and to make new friends in the process.

We will do our best to provide you with the quality of education that you expect from our institute.
We wish you the best of success during your studies and a pleasant stay at ITC and in The Netherlands.

Prof. Dr. Ir. M. Molenaar, Rector ITC

Introduction to ITC

One of humanity's greatest challenges is to achieve an appropriate balance between the development of natural resources and the maintenance of an optimal natural environment. To meet this challenge we need information on the earth's surface and sub-surface: spatially referenced information or *geo-information*.

Many different types of *earth observation* provide efficient ways of gathering geo-information. These types include conventional photographic and non-photographic imaging techniques, electro-optical sensing of the wider spectrum by multi-spectral, thermal infrared and radar scanning as well as geophysical and geochemical data-acquisition techniques. All these methods are used in mapping the earth's topography, monitoring the natural environment and exploring for natural resources and all are applied by specialist groups within the Institute.

ITC specializes in the collection, management and visualisation of geo-information and its integrated interpretation in support of resource management and policy development. In this way, scientific earth observation supports decision-making for sustainable development and the alleviation of poverty in the developing world.

The International Institute for Geo-Information Science and Earth Observation was established in 1950, and is usually referred to as ITC because of its original name: International Training Centre for Aerial Survey. It is the largest institute for international higher education in the Netherlands.

ITC is an autonomous organisation operating under the aegis of the University of Twente, and is funded by the Ministry of Education, Cultural Affairs and Science of the Netherlands. ITC is subject to the national quality assurance procedure for universities in the Netherlands. It is based in Enschede. ITC's main activities are education, research and advisory services. These activities are carried out by six scientific Departments:

- Department of Earth Observation Science (EOS)
- Department of Earth Systems Analysis (ESA)
- Department of Geo-information Processing (GIP)
- Department of Urban and Regional Planning and Geo-information Management (PGM)
- Department of Natural Resources (NRS)
- Department of Water Resources (WRS)

They are supported by the education, research, consultancy and general support departments.

Education

ITC has a scientific staff of some 150 professionals of 31 nationalities. More than 19,000 students from over 150 countries have graduated from courses at the institute since 1952. ITC offers courses at different levels: PhD degree (conducted in collaboration with Netherlands universities), Master of Science degree, Master degree, postgraduate and undergraduate Diploma and Certificate courses.

The ITC degree programmes are nationally accredited and registered in the Central Register of Higher Education (CROHO) of The Netherlands.

Recently ITC embarked on a programme of decentralizing its education, through joint education programmes with partners in various countries throughout the world. ITC also offers a growing number of distance education courses.

Updating the knowledge and skills of ITC alumni is an important task, in addition to the institute's regular courses. Therefore, ITC organises refresher courses at ITC and abroad.

The language of instruction is English.

Research

ITC carries out multidisciplinary and problem-oriented research that focuses on strengthening organisations involved in survey, management and planning for sustainable development. To this end, a strategic multidisciplinary research programme with the following themes is established:

- Biodiversity in fragmenting landscape
- Carbon-cycle and climate change
- Stochastic methods for image mining and data quality
- Disaster management
- Earth systems science
- Food security and environmental sustainability
- Governance and Integrated Spatial Assessment
- Spatial data infrastructure technology
- Spatio-temporal data integration and visualization
- Informed multilevel governance of urban regions
- Land administration for informed governance
- Managing water scarcity
- Sustainable urban-regional dynamics
- Utilisation of sensor developments for efficient topographic mapping
- Water cycle climate

Advisory services

ITC's transfer of knowledge also encompasses advisory services, mainly in developing countries. Advisory services of ITC often act as a follow-up service to alumni and their organisations and institutes.
Approximately 1000 projects have now been completed and ITC is presently committed to a wide variety of assignments around the world. The majority of these are based in developing countries and are education-oriented.

Introduction to ITC's educational programmes

At degree level ITC offers PhD, MSc and Master degree courses. Also Diploma courses, and short courses (some through distance education) are offered as part of the regular education.

The MSc degree programme in Geo-Information Science and Earth Observation (lasting 18 months) consists of seven courses, each with a specific orientation:

- **Applied Earth Sciences**
- **Geoinformatics**
- **Governance and Spatial Information Management**
- **Land Administration**
- **Natural Resources Management**
- **Urban Planning and Management**
- **Water Resources and Environmental Management**

The Master degree programme (lasting 12 months) consists of two courses:

- **Geoinformatics**
- **Natural Resources Management**

Postgraduate Diploma courses (lasting 9 months) are offered in:

- **Applied Earth Sciences**
- **Geoinformatics**
- **Land Administration**
- **Natural Resources Management**
- **Urban Planning and Management**
- **Water Resources and Environmental Management**

Programmes in cooperation with other institutes
ITC cooperates with Universities in The Netherlands, Europe and throughout the world in full-time and part-time joint education programmes, leading to MSc and Master degrees and to Diplomas:

- In The Netherlands ITC cooperates with the universities of Utrecht, Delft and Wageningen in an MSc course, focusing on Geographic Information Management and Applications (GIMA). The course is offered through distance learning, with four periods of classroom learning.
- In Europe, ITC cooperates with the universities of Southampton, Lund and Warsaw in an MSc course on Geo-information Science and Earth Observation for Environmental Modelling (GEM). The course is taught in four countries: UK, Sweden, Poland and The Netherlands.
- ITC has entered into partnership with reputable education institutes for the purpose of providing joint courses in several countries throughout the world. At present, MSc and Master courses are or will be conducted in Bolivia, China, Ghana, India, Indonesia, Iran, Kenya, Mexico, Nigeria and Tanzania.

For more information on our joint courses, please consult the ITC website (http://www.itc.nl/education/jointcourses.aspx).

Master of Science degree, Master degree and Postgraduate Diploma

Master of Science degree

The 18 month Master of Science degree programme is intended for participants with a future task in research and development. In addition to 12 months regular coursework, the Master of Science participants learn by doing research and/or by developing new methods or techniques in a 6 months thesis period.

Successful completion of the MSc degree programme provides graduates with a qualification that enables them to continue to PhD level, either in the Netherlands or abroad.

All Master of Science courses lead to a degree with the title:
"Master of Science in Geo-Information Science and Earth Observation".

Master degree

The 12 month Master degree programme is more profession oriented and teaches more practical skills. It could be compared to taught masters in other countries.

All Master courses lead to a degree with the title:
"Master in Geo-Information Science and Earth Observation".

Postgraduate diploma

The 9 month Postgraduate diploma programme caters for young and mid-career professionals who need to be proficient in applying geo-information science and earth observation in their field of interest, analysing problems and applying new methods and techniques, and managing (multi)disciplinary scientific teams.
The Postgraduate diploma course is equal to the taught part of the MSc course.

The Postgraduate Diploma course leads to a Diploma with the title:
"Postgraduate Diploma in Geo-Information Science and Earth Observation''

Course structure

The duration of the Master of Science courses is 18 months, of the Master courses 12 months and of the Postgraduate Diploma course 9 months.
All ITC courses are divided into 3 week periods (modules) or multiples of 3 weeks (blocks) in which one subject or related subjects are taught. All Master, Master of Science and Postgraduate Diploma courses start on the same date in September each year. The Postgraduate Degree programme is taught together with the MSc programme during the first nine months. The Master programme is taught separately after module 4.

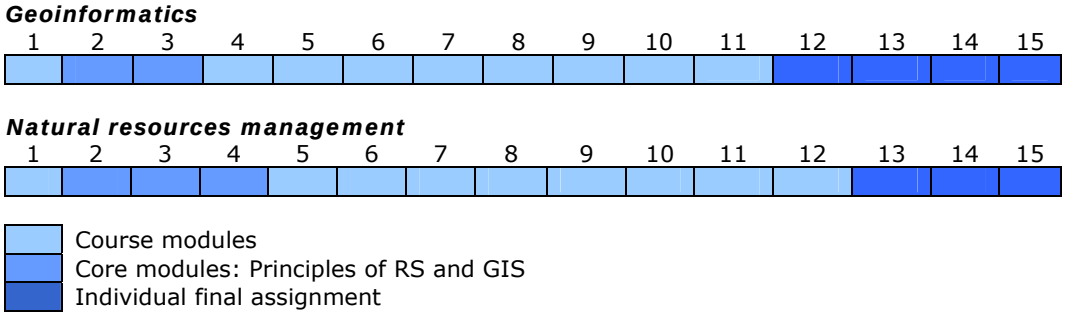
ITC's core business is the collection and handling of geo-information and its application in various fields involved in sustainable resource development. ITC has given its core business a prominent place in the courses. Block 1 (modules 1-4) in all degree courses contains ITC's core curriculum: (at least) three weeks of these core modules are spent on Geographic Information Systems (GIS) and (at least) three weeks are spent on Remote Sensing. In addition to these core modules all programmes offer more advanced modules in geo-information and earth observation techniques that vary per course.

Master programme

The Master programme is made up of 15 modules, consisting of core modules about GIS and Remote Sensing, course modules, and an individual final assignment.

Figure 1

Structure of Master courses



Course module 1

In the first module, the course domain and principles of databases are introduced.

Core modules

Modules 2 and 3 teach the basic principles of Remote Sensing and GIS, and how these can be applied in various domains. This common core ensures a basic level of GIS and RS for all students, regardless of their background and experience. The core modules are taught together in class with the MSc and PGD students.

Course modules 4-11

In these modules of the Geoinformatics Master Course the concepts and technology of Spatial Data Infrastructure (SDI) are taught.

Individual final assignment

The Master programme concludes with an individual final assignment in which the participant can work on a case and topic which is tailored to his or her particular situation and interest. Participants are encouraged to bring data and other material from their home country for this purpose, subject to approval.

Study load of the ITC degree programmes

The European Union has developed a European Credit Transfer System (ECTS) to allow easy comparison of study load of courses within Europe. ITC has adopted this system as a means of improving academic recognition for study abroad.

In ECTS, 60 credits represent the workload of an academic year (9-10 months) of study. These include lectures, practical work, seminars, tutorials, fieldwork, and self study. At ITC, each module of three-week duration has a study load of 5 ECTS.

The MSc course consists of 23 modules and three additional weeks of remedial teaching, catch-up activities and graduation ceremonies, totalling 118 ECTS. The Master course consists of 15 modules and two weeks of remedial teaching, catch-up activities and graduation ceremonies, totalling 77 ECTS. The Postgraduate Diploma course consists of 12 modules and 1 week of remedial teaching, and catch-up activities, totalling 61 ECTS.

Opening hours of various ITC facilities

ITC building	
Monday-Thursday	07:30 - 22:30
Friday	07:30 - 21:00
Saturday	09:00 - 17:00

Bookshop (room 0-006)	
Monday-Friday	08:30 – 12:15 12:45 – 16:00

Library (room 3-038)	
Monday, Thursday, Friday	08:30 - 17:00
Tuesday, Wednesday	08:30 – 21:00

Audio-Visual centre (room 3-039)	
Monday, Thursday, Friday	08:30 - 17:00
Tuesday, Wednesday	08:30 – 21:00

Students' financial administration desk (room 1-130)	
Monday-Friday	10.30 – 13.30

Computer helpdesk (room 1-004)	
Monday-Friday	08:30 - 12:45 13:30 – 17:00

Restaurant (ground floor)	
	Monday-Friday
Coffee break *free coffee/tea*	10:15 – 10:45
Lunch	12:00 - 13:30
Tea break *free coffee/tea*	15:15 – 15:45

Starting dates modules and holidays

Module number	2008 / 2009 / 2010
Registration *Opening Academic year*	*Monday, September 15, 2008* *Thursday, September 25, 2008*
Module 1	September 29 through October 17
Module 2	October 20 through November 7 *RS core exam: November 7*
Module 3	November 10 through November 28 *GIS core exam: November 28*
Module 4	December 1 through December 19 *RS core re-sit exam: December 10*
DIES celebration	*GIS core re-sit exam: December 17: morning* *Wednesday, December 17: afternoon no classes*
X-mas	*December 25 through December 26*
New Year	*January 1, 2009*
X-mas break	*December 22, 2008 through January 2, 2009*
Module 5	January 5 through January 23, 2009
Module 6 *MSc day*	January 26 through February 13 *Wednesday, January 28, 2009*
Module 7	February 16 through March 6
Module 8 *MSc fair*	March 9 trough March 27 *Wednesday, March 11, 2009*
Module 9	March 30 through April 17
Good Friday	*April 10*
Easter Monday	*April 13*
Module 10	April 20 through May 8
Queen's day	*Thursday, April 30*
Liberation day	*Tuesday, May 5*
Catch-up week	*May 11 through May 15*
Module 11	May 18 through June 5
Ascension Day + compulsory ADV	*May 21 through May 22*
Whitsun Monday	*June 1*
Closing week PGD	*June 8 through June 12*
Closing PGD	*Friday, June 12*
Module 12	June 8 through June 26
Module 13	June 29 through July 17
Module 14	July 20 through August 7
Module 15	August 10 through August 28
Closing week Master - Catch-up week MSc	*August 31 through September 4*
Graduation Master	*Friday, September 4*
Module 16	September 7 through September 25
Module 17	September 28 through October 16
Module 18	October 19 through November 6
Module 19	November 9 through November 27
Module 20	November 30 through December 18
X-Mas, New year break	*December 24, 2009 through January 1, 2010*
Module 21	December 21, 2009 through January 15, 2010
Module 22	January 18 through February 5
Module 23	February 8 through February 26
Closing week MSc	*March 1 through March 5, 2010*
Graduation MSc	*Friday, March 5, 2010*

Geoinformatics

Geographic and earth sciences rely increasingly on digital spatial data acquired from remotely sensed images, analysed through geographical information systems and visualised on the computer screen or on paper. The technologies supporting the processes of acquisition, analysis, visualisation and dissemination of spatial data form the core of Geoinformatics. Technological skills alone, however, are not sufficient for organisations involved in the production and management of geo-information. To optimise the use of technology, additional capabilities must be available, such as a thorough understanding of efficient data collection, the structuring of spatial databases and data output by visualisation techniques, as well as a sound organisational infrastructure for the management of and access to the data. Organisations must be able to keep pace with developments in electronic data dissemination.

General outline

The course is composed of a series of modules, each lasting three weeks. There are three types of modules: core modules, programme modules, and elective modules.

The core modules, which are followed by participants from all programmes, cover the basic concepts, tools and techniques of GIS and remote sensing. Knowledge of the principal concepts of spatial data acquisition through remote sensing and spatial data handling with GIS is supplemented by developing the practical skills required to apply these tools. Throughout other modules, GIS and remote sensing and image processing tools are applied regularly. This provides the opportunity to develop a full understanding of their relevance to Geoinformatics, and the ability to extract maximum utility from their use. In addition, especially for the Geoinformatics programme, much emphasis is placed on database principles in these modules.

The course modules, are the follow up of the core modules with a string of more in-depth modules related to Geoinformatics technology, research or system design and production. These modules are different for the two degree courses, the MSc track focussing more on research in Geoinformatics, and the Master track focussing more on industrial needs, in an engineering sense, for Geoinformatics and its tools and applications.

In the Master course, the overall theme is the application of technology for Spatial Data Infrastructures (SDIs). Various modules address specific aspects of the theme, and all aim at improving the understanding and engineering skills of the course participants:

- design and developments of component systems SDI, core geospatial;
- data provision, methods and techniques of geospatial data;
- acquisition, and its eventual (web based) dissemination.

The advanced topics module allows a deepening of knowledge and skills in a sub-domain of the general SDI theme. In this way, the participants can specialise their engineering skill according to personal and organisational interest and/or demand.

The Individual Assignment is lasting for twelve weeks, including an excursion and the proposal writing. During this part of the course, the participant applies the knowledge gained and develops an engineer project and product. A report and presentation finalises the course and marks the end of the regular course participant's efforts for their stay at ITC.

Detailed objectives of the Master course (GFM M)

On completion of the course, the participant must be able to:

- analyze geo-technical problems and design production processes of geospatial data and services for different application fields of geoinformation;
- give support to the design of and implement technological SDI components in an organization;
- evaluate (intermediate) information products, which can be used as building blocks for multi-level SDIs;
- evaluate the performance of production and dissemination processes;
- work in multidisciplinary teams engaged in production projects, which involve spatial data collection, database management and data dissemination;
- transfer the gained knowledge into the own work environment.

Educational methods

The course offers an attractive and intensive educational package including lectures, practical exercises, multidisciplinary project work and hands-on case studies. Practical exercises are normally divided into periods with close staff supervision and periods during which participants are expected to work on their own. Including self study, the study load for the average participant is estimated to be 45 hours per week. Apart from public holidays and a week at Christmas, there are no vacation periods in the intensive programme.

Throughout the course, links are made to the participants' work experience thus matching theoretical knowledge with a practical problem-solving approach, considering the many applications of geospatial data. Most of the practical work of the programme involves computers, usually in open-access computer clusters. During the MSc and IFA periods, participants are expected to work largely independently with a minimum of supervision.

A case study is part of the course. The goal of the case study is to apply the knowledge acquired in the module 5 to 10 into building a coherent system for spatial data acquisition, storage, access, analysis and dissemination, that complies to SDI qualities and standards.

The participants will learn, additionally to modules 1-10 of the course, programming skills and the use of one computer programming language.

Organisation and staff of the Geoinformatics courses

Course Director and Course co-ordinators		
	Room	Phone
G.C. Huurneman MSc; GFM Course Director	2-009	216
Ms Dr.Ir. W. Bijker; Course co-ordinator of the Master of Science Degree course	2-040	203
Dr. Ir. R.L.G. Lemmens; Course co-ordinator of the Master Degree course	1-064	529
A.M. Mank; Course co-ordinator of the Diploma course	1-033	459

Administrative and supporting staff		
	Room	Phone
Ms D.E. Scholten; course secretary MSc, PG and Diploma course	2-105	334
Ms L.J.C. Windig; course secretary Master course	2-105	464
Ms. J.M. Mol; course secretary Short Courses	2-105	480

Master Degree Course in Geoinformatics

Duration of the module		Module	Co-ordinating staff member		
		MSc and Master modules			
Module 1:	29-09-08/17-10-08	Introduction, Principles of Databases	Dr. Ir. R.A. de By	Modules 1-4: **Programming Skills Part I** Coordinator: Dr. O. Huisman	
Module 2:	20-10-08/07-11-08	Principles of Remote Sensing	J.P.G. Bakx MSc		
Module 3:	10-11-08/28-11-08	Principles of Geographic Information Systems	Dr. C.P.J.M. van Elzakker		
Module 4:	01-12-08/19-12-08	Mathematics and Programming	Prof. Dr. Ir. M.G. Vosselman		
		Master modules		Modules 5-10: **Programming Skills Part II** Coordinator: Dr. O. Huisman	Modules 5-10: **Case Study** (2 days per module). Co-ordinator: drs B..J. Köbben
Module 5:	05-01-09/23-01-09	Sensor Orientation, DTM and Orthophoto Production	Dr. K. Tempfli		
Module 6:	26-01-09/13-02-09	Spatial Data Modelling	Dr. R.A. de By		
Module 7:	16-02-09/06-03-09	SDI Engineering	Dr. O. Huisman		
Module 8:	09-03-09/27-03-09	Base mapping from images	Dr. K. Tempfli		
Module 9:	30-03-09/17-04-09	Process Modelling, Programming and Dissemination	Ms. Ir. P.W.M. Augustijn		
Module 10:	20-04-09/08-05-09	Dissemination and Visualization of Geospatial Data	Dr. C.P.J.M. van Elzakker		
Catch-up week:	11-05-09/15-05-09				
Module 11:	18-05-09/05-06-08	Advanced Topics and Master Skills	Dr. C.P.J.M. van Elzakker & Dr N. Hamm		
Module 12:	08-06-09/26-06-09	Individual Final Assignment preparation, Excursion	Dr. Ir. R.L.G. Lemmens	1 week finalising Case Study	
Module 12-15:	29-06-09/28-08-09	Individual Final Assignment	Dr. Ir. R.L.G. Lemmens		
Closing week:	31-08-09/04-09-09				

Introduction and Principles of Databases			
Module: 1		Co-ordinating staff: Dr.Ir. R. A. de By	
Start:	29-09-2008		
End:	17-10-2008		
Level: M, MSc, PG			M08-GFM-160

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

Contents
The module covers the following topics:
- What purposes do databases serve?
- Database Management Systems.
- The relational data model.
- Set theory and mathematical logic as a foundation for database querying.
- Database querying using SQL.
- Database maintenance.
- Introduction to database design.

Objectives
Main objective: To learn how a database management system works, what stored tables and queries are, and how to define queries in the standard language SQL. Applying all that knowledge to improve an existing database, allowing us to extract information that was originally impossible to extract. Also, the first aspects of database design.

Upon completion of this module student should be able to:
- Explain the fundamentals of the relational data model,
- Formulate simple queries in mathematics,
- Define, execute and verify SQL queries against an existing relational database,
- Improve a badly designed database, and
- Database design: UML class diagrams.

Prerequisites
Basic computer handling skills, some familiarity with Windows software, secondary school discrete mathematics, ability to explore new software and new data sets, group collaboration.

Recommended Knowledge
Basic computer skills, basic mathematics.

Hardware and Software Requirements
Computer cluster. MS Access, MS Excel, MS Word.

Teaching Materials
Principles of Databases, LA/GFM Course Reader, Reader Exercises Databases. Various.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
36	38	0	30	0	16	10

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

In the third week, students will carry out an assignment in groups of three to five students. The work consists of re-organizing a database through queries, and preparing the answers to a number of given data analysis problems. The work is concluded with a small report and a finalizing discussion with the supervisors. The group effort is given a mark between 10 and 100; it will be the first full module mark for each student. In exceptional cases, students may be taken apart for a separate, individual assessment.

Note(s)

Principles of Remote Sensing			
Module: 2		Co-ordinating staff: M.Sc. J.P.G. Bakx	
Start:	20-10-2008		
End:	07-11-2008		
Level: M, MSc, PG			M08-GFM-161

Introduction

This module introduces the principal concepts and techniques remote sensing. The module consist of lectures explaining the theory and focusing on the concepts, and practical's aiming at illustrating the lectures and developing hands-on skills in using (mostly software) tools, carrying out sequential data processing steps for solving typical application problems. The concepts and techniques introduced in the module will be further used and developed during subsequent modules.

Contents

The module covers the following topics:

- The electromagnetic spectrum
- Sensors and platforms
- Radiometric aspects of remotely sensed data
- Geometric aspects of remotely sensed data
- Aerial photography.
- Image enhancement and visualization
- Image interpretation and classification

The module contains the following GFM specific topics:

- Radar
- Laser scanning

Objectives

Main objective. To learn how to generate information about the Earth from remote sensing data. At the end of the core modules participants must be able to:

- Explain the principles and use the vocabulary of RS;
- Describe the physical background of remote sensing and compare the main platforms and sensor systems;
- Explain the main digital image processing procedures;
- Describe the common methods of image analysis;
- Perform basic image processing techniques;
- Carry out a visual interpretation of an AP stereo pair and a satellite image;
- Apply appropriate RS methods for problem solving;
- Understand the capabilities, uses and limitations of RS in their field of application;
- Design and carry out sequential data processing steps for solving a typical application problem;
- Evaluate the results of data processing.

Prerequisites

Not applicable.

Recommended Knowledge

Basic computer skills, basic mathematics, stereo vision.

Hardware and Software Requirements

PC; Image Processing Software (ERDAS Imagine) and GIS software (ArcGIS).

Teaching Materials

- Principles of Remote Sensing, ITC Educational Textbook.
- Reader Exercises RS.
- Handouts of lectures.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
34	36	4	8	0	28	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Written closed book exam on (parts of) the ITC RS textbook.

Note(s)

Examination on this core module contents is based upon the generic topics and will have ITC wide coordination. A precise list of compulsory topics and Textbook paragraphs will be distributed.

Principles of Geographic Information Systems			
Module: 3		Co-ordinating staff: Dr. C.P.J.M. van Elzakker	
Start:	10-11-2008		
End:	28-11-2008		
Level: M, MSc, PG			M08-GFM-162

Introduction

This module introduces the principal concepts and techniques of geographic information systems (GIS). The module consists of two interrelated parts: a theoretical one that focuses on the concepts and a practical one that aims at developing hands-on skills in using (mostly software) tools. The concepts and techniques introduced in these modules will be further enhanced during subsequent modules of the course.

Contents

The module covers the following topics:

- Introduction to GIS.
- Geographic information and spatial data types.
- Data processing systems.
- Determining and mapping position.
- Spatial data entry and preparation.
- Spatial data analysis.
- Spatial data visualization.

Objectives

Main objective: To learn how to generate information about the Earth from data stored in Geographic Information Systems. At the end of this core module, participants must be able to:

Explain the principles and use the vocabulary of GIS:

- Describe the nature of geographic phenomena and their representation in the context of geo-informatics;
- Outline the principal data models for spatial and non-spatial data used in GIS databases;
- Outline the main components of a GIS and their functions;
- Explain the relationship between spatial data and coordinate systems;
- Outline the main spatial data analysis functions;
- Outline the principal rules for cartographic visualisation;
- Describe aspects of data quality and how various stages of spatial data handling affect it.

Carry out basic GIS operations:

- Carry out basic data preparation, geo-referencing and data entry into a GIS;
- Perform basic manipulation, analysis and visualisation operations using a GIS;
- Apply basic data quality assessment procedures.

Apply appropriate GIS methods for problem solving:

- Understand the capabilities, uses and limitations of GIS in their field of application;
- Design and carry out sequential data processing steps for solving a typical application problem;
- Evaluate the results of data processing;
- Be aware of organisational issues of GIS development and implementation.

Prerequisites

Not applicable.

Recommended Knowledge

Basic computer skills, basic mathematics.

Hardware and Software Requirements
ITC cluster PC with standard software and ArcGIS9.3.

Teaching Materials
Principles of Geographic Information Systems, 4th Edition, 2008. ITC Educational Textbook Series.
Principles of Geographic Information Systems, Exercises. Version 7.0, 2008.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
30	34	0	0	0	62	10

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Written closed book exam on the ITC GIS textbook referred to above.

Note(s)

Mathematics and Programming			
Module: 4		Co-ordinating staff: Prof. Dr.Ir. M.G. Vosselman	
Start:	01-12-2008		
End:	19-12-2008		
Level: M, MSc, PG			M08-GFM-163

Introduction
This module is designed to prepare the course participants for the domain specific part of the course. It will bridge the gap between the analytical knowledge base of the student from a wide range of diverse disciplines to the required appreciation for basic/universal mathematical concepts upon which the geoinformation technology is built. Furthermore it will include lectures and a larger assignment to further develop the programming skills.

Contents
Linear Algebra
- Vectors in 2D & 3D space
- Vector space
- Matrix operations
- Transformations(Linear, Projective, DLT)
- Eigenvalues and Eigenvectors

Calculus
- Differentiation
- Integration
- Partial Differentiation
- Implicit Differentiation
- Taylor and MacLaurin series for one or several variables and numerical applications

Programming
- See the separate description of Programming Skills I

Objectives
To introduce students to some of the mathematical principles which underline spatial application technology and tools. To equip students with adequate knowledge in programming language to construct simple spatial tools in existing geospatial applications.

Prerequisites
Modules 1- 3.

Recommended Knowledge
Basic mathematics at BSc level.

Hardware and Software Requirements
Cluster with standard software. Python.

Teaching Materials
Lecture notes and slides, Python Tutorial.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
32	6			28	66	12

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Two assessments with marks:

1. Programming skills: Individual programming assignment;
2. Mathematics: Written exam.

Note(s)

Programming Skills I			
Module: 1-4		Co-ordinating staff: Dr. O. Huisman	
Start:	29-09-2008		
End:	19-12-2008		
Level: M, MSc, PG			U08-GFM-159

Introduction

The main objective of this course component is to provide a working knowledge of programming in the Python programming language. Python is a General-purpose open-source computer programming language used by hundreds of thousands of developers around the world, in areas as diverse as spatial modelling, internet scripting, user interfaces, product customization, and more. Using a variety of theoretical and applied examples from each of the modules, students will learn how to think in a structured, logical way. "Programming Skills" will be taught and exercised in the first and second week of each module, but not in the exam week of any module.It will be assessed through regular exercises and project-based work.

Contents

- What is a program?
- The difference between interpreted scripts and compiled code
- Variables, Expressions and Conditions
- Functions
- Recursive tasks
- Working with Strings and Lists

Objectives

After completing this course component students should be able to:

- Think analytically about a computational problem, i.e. be able to decompose and structure a problem,
- Formulate algorithms, which solve a given (simple) problem, and
- Implement these using Python.

Prerequisites

Not applicable

Recommended Knowledge

Not applicable

Hardware and Software Requirements

The Python programming environment, plus additional modules.

Teaching Materials

- The book How to Think Like a (Python) Programmer, Allen Downey, Green Tea Press, 2007.
- Lecture notes and slides available via Blackboard.
- Exercises and puzzles, distributed via Blackboard.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	24	0	0	0	12	12

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Students are required to submit completed exercises at the end of each module. The mark allocated for this course component will make up a component of the overall mark for Module 4.

Note(s)

Sensor Orientation, DTM and Orthophoto Production			
Module: 5		Co-ordinating staff: Dr. K. Tempfli	
Start:	05-01-2009		
End:	23-01-2009		
Level: M			M09-GFM-107

Introduction

The module introduces processes and systems of geo-spatial data acquisition based on current sensor technology. The sensors to be considered are positioning and orientation systems, cameras, laser scanners, and SRTM. The focus is on geometric processing of raw sensor data in order to obtain "primary 3D data", ie, oriented photographic images from air and space, digital surface models, digital terrain models, and orthophotos. The treated GI products can serve as a spatial data component in an SDI and as basis for and object recognition and reconstruction procedures. The latter will be subject of module 8.

Contents

The main groups of subject are:

- Spatial reference frames and GPS
- Direct and indirect sensor orientation
- Digital terrain modelling
- Orthophoto production
- Standards, specifications, and data quality of considered products
- Programming

Objectives

Upon completion of this module students should be able to:

- Explain the standard processes of generating primary 3D data from active and passive sensors and current systems
- Explain the impact of new sensor technologies on the generation of primary 3D data.
- Interpret standards and specifications; explain and apply quality control procedures.

Prerequisites

Modules 1 to 4 of the GFM programme.

Recommended Knowledge

Core concepts of remote sensing, coordinate transformations, basic statistics.

Hardware and Software Requirements

Leica GPS receivers and software. Computer Cluster(s): ERDAS IMAGINE, Leica Photogrammetry Suite (LPS), SURFER.

Teaching Materials

Hardcopy hand-out containing reading material, a B&W copy of the lecture slides, and exercise/assignment instructions; PDF's of the lecture slides in Blackboard. Images and data for the exercises/assignments.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
28	28	0	0	8	24	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Presentation at the computer and discussion on the practical assignments, weighted 60%. Written examination weighted 40%.

Note(s)

Spatial Data Modeling			
Module: 6		Co-ordinating staff: Dr.Ir. R. A. de By	
Start:	26-01-2009		
End:	13-02-2009		
Level: M			M09-GFM-108

Introduction

An important aspect of a successful information infrastructure (II) is the correct design and implementation of its constituent parts, especially the information systems. In an II, many users share the same information, typically for many years into the future. It is of strategic importance that such information is correct and up-to-date, available around the clock, and protected against abuse. All of this can be achieved if the systems are designed well. And information system design starts with data modelling.

Spatial database technology is key when multiple users want to share spatial data sources over prolonged periods of time. They allow storing spatial data sets, keeping them consistent and up-to-date, analysing the data and deriving useful information from it. They have been devised to allow multiple users access at the same time, while guarding against inappropriate data use or data change. They also offer advanced computations with the data.

Spatial databases especially offer support for spatial data in vector format. They provide the best technology for maintaining spatial data sources, especially in geo-information projects with indefinite lifetime. The application of spatial database technology is the topic of study in this module.

Contents

We will be looking specifically at a standard for spatial database organisation, the OGC Simple features for SQL standard, as well as the best open-source implementation of it, PostgreSQL with its PostGIS extension. In sequel, we will discuss:

- Principles of spatial database design
- UML as a modelling language
- Interoperability and spatial data standards
- Object-relational database management and spatial data handling

Objectives

The module aims to provide the student with a thorough understanding of the above-mentioned technology, as well as the skills required to operate it in industrial settings. Upon completion of the module, the student should:

- Understand and be able to apply the principles of spatial database design, using transformational techniques,
- Be able to implement a working spatial database prototype and load it with spatial data,
- Be able to explain the role of data standards in this field,
- Be proficient in defining and executing spatial queries and transactions on the database,
- Be able to explain the role of types, domains, constraints, views, triggers and privileges.
- Be able to define in these on an existing database.

Prerequisites

The following subjects should be known by the students:

- The relational data model
- The use of SQL
- Basics of UML class diagrams
- Standard data models, especially for vector data sets, as supported by GIS software packages
- Principles of data acquisition and their output data formats

Recommended Knowledge

The following subjects are not required knowledge, but acquaintance with them will help the student to understand the module's content more easily. The list also serves as a further characterisation of the module's content.

- First-order predicate logic as applied in database querying
- Experience with any computer programming or scripting language
- Experience in GIS projects, especially the design of a GIS application
- Knowledge of SDI systems and their set-up.

Hardware and Software Requirements

The module will be executed in different formats with a few lectures, self-study followed by presentations, and practicals. There will also be a practical assignment that leads to a mark.

Students will be in need of a standard cluster PC with internet connection, and access to a tool for UML modelling as well as to a PostgreSQL/PostGIS server. This will require at least two client software packages: one SQL client to operate on the database proper, and another to visualize the spatial data.

Teaching Materials

The following materials will be used:

- Reader with self-study materials
- Blackboard with online contents, background materials, manuals and slides
- An exercise database for the assignment

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
20	10	0	0	24	70	20

Time (in # of hours) allocated per major method:

L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Assessment takes place on the basis of two equally weighted components:

- A written examination over the theory of the module
- A demonstration of the results of the design and implementation project

Note(s)

SDI Engineering			
Module: 7		Co-ordinating staff: Dr. O. Huisman	
Start:	16-02-2009		
End:	06-03-2009		
Level: M			M09-GFM-109

Introduction

Spatial Data Infrastructures (SDI) are becoming increasingly important in the Geoinformation community. Seconded by an increasing political interest, nowadays most major organizations which deal with spatial data acquisition, management and dissemination are involved in SDI development activities. Against this background this module focuses on engineering methods used to build up Spatial Data Infrastructures on corporate, local, regional and national levels.

Contents

- Revisit of the SDI concept
- Layered and service-based architectures for distributed software systems
- Interoperability – Why is it necessary and how can it be achieved?
- Principles of internet-based GIS
- Core technologies for web applications (particularly XML)
- International standardization efforts for interoperable GI services (OGC, ISO)
- Commercial and Open Source solutions for setting up interoperable SDI nodes

Objectives

Upon completion of this module students should be able to:

- Explain fundamental SDI concepts and be able to identify technological requirements for successful implementations,
- Explain the concepts of (syntactic and semantic) interoperability to be sensitive for integration problems in heterogeneous environments,
- Describe basic software architectures (monolithic, client/server, service oriented) and be able to assess their use in an SDI context,
- Describe international GI-related standardization efforts to be able to efficiently design and implement interoperable SDI nodes,
- Explain fundamental web technologies to be able to customize and deploy Internet GIS components,
- Understand and explain standards-based web services to setup core SDI nodes.

Prerequisites

Modules 1 to 6 of the GFM programme.

Recommended Knowledge

Not applicable

Hardware and Software Requirements

Standard PC in clusters (one per student) equipped with:

- UMN MapServer
- MS Visio

Teaching Materials

Course reader and slides

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
27	18	0	23	0	51	3

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Group/individual assessment (40%) and written exam (60%)

Note(s)

Base mapping from images			
Module: 8		Co-ordinating staff: Dr. K. Tempfli	
Start:	09-03-2009		
End:	27-03-2009		
Level: M			M09-GFM-110

Introduction
This module deals with acquiring and updating vector data in an SDI setting. In doing so the focus is on extracting features from optical sensor data particularly related to topographic objects, covering the traditional field of large scale topographic mapping and cadastral mapping. The topics of the module span the entire production range from analyzing data requirements for base mapping to validating produced data.

Contents
- Base map standards and specifications.
- Characteristics of very high resolution optical sensors for base mapping.
- Manual and semi-automatic feature extraction from photographic images.
- Change detection and geometric registration for base map updating.
- Quality control procedures for vector data, including field completion.
- Geo database generation/population.
- Metadata provision.
- Programming.

Objectives
Upon completion of this module students should be able to:
- Identify required and suitable sources for data acquisition based on product specifications.
- Interpret standards and define specifications for data acquisition.
- Analyze spatial data models, select the appropriate data acquisition methods and evaluate their performance.
- Select the appropriate data updating methods and apply them (in a distributed environment).
- Explain quality concepts for spatial data (including error propagation and apply common tools in quality control procedures).
- Identify the interfaces of working in a team where more specialized knowledge is available on computer science, database design, spatial analysis, geo-visualization, and the application fields (urban planning, land administration, disaster mitigation).

Prerequisites
All previous modules and in particular the modules 5 and 6.

Recommended Knowledge
Basic statistics. Database design. Familiarity with ArcGIS, LPS/stereo-analyst, Excel.

Hardware and Software Requirements
PCs, internet, ERDAS, LPS, ArcGIS, Excel; GPS receivers.

Teaching Materials
Hardcopy hand-out containing reading material, a B&W copy of the lecture slides, and exercise/assignment instructions; PDF's of the lecture slides in Blackboard. Top10-vector data of Enschede, large scale base data of Enschede including cadastral data, aerial photos of Enschede, GCP's.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
22	36	0	0	10	44	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Written reports and discussion on the practical assignments.

Note(s)

Process Modelling, Programming and Dissemination			
Module: 9		Co-ordinating staff: Ir. P.W.M. Augustijn	
Start:	30-03-2009		
End:	17-04-2009		
Level: M			M09-GFM-111

Introduction

Focus in this module will not be on individual analysis but on creating geo-processing models that contain a series of analytical operations, and can be re-executed, stored and shared. Module will cover both the design and the implementation of analytical models. To follow this module, students need a basic understanding of spatial analysis and programming. Models should be designed in such a way that they can use input from many different sources (including internet) and that results can be disseminated in different ways (including dissemination through the internet).

The ArcGIS platform will be used for developing the models, Python will be used as the programming language, and ArcIMS for internet dissemination.

Contents

- Conceptual knowledge on types of analytical models, including static and dynamic models, individual and aggregate models, cellular models and agent-based model (ABM).
- Extend (built on) existing knowledge on Spatial data analysis including network analysis and raster analysis.
- Development of skills in creating conceptual models for analytical problems
- Skills in the implementation of simple and complex models in the ArcGIS environment using Model Builder and as Analytical geoprocessing scripts in Python
- Evaluation of output of analytical models, error propagation. Accuracy and validity of models (verification, calibration and validation).
- Case study.

Objectives

Upon completion of this module students should be able to:

- Have a general understanding of analytical models (process models, prediction models, binary models, weighted models etc).
- Identify required analyses and specify these analyses in a geo-processing model design.
- Create models to automate the geo-processing tasks using a visual environment to design the geo-processing work flow.
- Extend geo-processing models with custom scripts using a COM compliant scripting language, to do batch processing, branching based on conditions, and to enhance standard functionality with custom tools.
- Evaluate the model on error propagation caused by the spatial data processing.
- Aim for interoperability between the models and the internet both on the data input and the information dissemination side.

Prerequisites

Module 3, 6, 7 and 8 of GFM.3. Programming (Python).

Recommended Knowledge
Core book 'Principles of Geographic Information Systems' chapter 2 and 6.Practical skills in ArcGIS and ArcIMS. Good programming skills (Python).Case data collected in module 5 and 7.

Hardware and Software Requirements
ArcGIS, ArcIMS and Python.

Teaching Materials
Reader containing compilations of slides, exercises and reading material. Blackboard for datasets and solutions for exercises.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
20	28	0	0	18	12	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Assessment for this module will be based on hand-in assignments.

Note(s)

Dissemination and Visualization of Geospatial Data			
Module: 10		Co-ordinating staff: Dr. C.P.J.M. van Elzakker	
Start:	20-04-2009		
End:	08-05-2009		
Level: M			M09-GFM-112

Introduction

The preceding GFM.3 Course Modules and the ITC Core Modules have dealt with all aspects related to the design and implementation of SDI's, except for the final stage: dissemination of the geospatial data to the users. After all, the use that can be made of the data in a SDI is the key to its success! Maps, often in the form of dynamic and interactive displays on computer screens, are effective means of geospatial data dissemination. So, geovisualization is an important topic in this module, not only for presentation to users, but also for the exploration, analysis and synthesis of geospatial data by the users themselves. But, next to map displays, other spatial data products will be treated in this module as well and attention will be paid to use related issues like generalization.

Contents

Dissemination and use of geospatial data:

- roles of maps in a SDI;
- dissemination methods and environments (SDI, the Web);
- user-centred design based on analysis of user requirements;
- usability of various methods of geospatial data dissemination;
- production of hard and soft copy output;
- generalization;
- geometric aspects of mapping.

Visualization of geospatial data in a GIS / SDI environment:

- cartographic design aspects (cartographic grammar, use of colour; map layout and text);
- thematic mapping methods;
- topographic mapping (including the required spatial modelling);
- dynamic visualization;
- open standards Web visualization.

Practical application of the theory on geovisualization and usability in the GFM.3 Case Study.

Objectives

Upon completion of this module students should be able to:

- Describe and follow a user-centred design approach in setting up geospatial data dissemination systems.
- Analyze and describe geospatial data needs for different applications and the requirements of specific uses and users of geospatial data.
- Distinguish dissemination methods and environments and explain their role in geospatial data provision for different kinds of use and users.
- Explain the different roles of (interactive) maps in SDI`s (maps for exploration, analysis, synthesis and presentation, maps as interface to / preview of geospatial data).
- Derive various and suitable data products from a SDI (both in hard and soft copy format).
- Understand the geometric components of map displays.
- Select suitable map projections.
- Determine datum transformation parameters.
- Find and execute solutions for generalization in geovisualization and geospatial data dissemination; understand the consequences of multi-scale geovisualization.
- Understand the role of visualization in geospatial data processing.

- Understand, explain and apply the principles of cartographic design in relation to use and user requirements and the nature of the geographic information (including temporal components).
- Distinguish and apply various thematic mapping methods.
- Understand and explain the need for and be able to apply spatial modelling for topographic mapping.
- Understand and apply open standards for Web visualization.
- Evaluate the characteristics and usability of different methods of geospatial data visualization and dissemination in successive stages of geo-information processing.

Prerequisites
Modules 1 - 9 of GFM Master

Recommended Knowledge
Reading skills

Hardware and Software Requirements
PC's (one system per student) with ArcGIS 9.3, Internet access, standard office software and the software required for the execution of the GFM.3 Case Study.

Teaching Materials
Commercial textbook: M.J. Kraak & F.J. Ormeling (2003), Cartography: Visualization of Geospatial Data. Second edition. Harlow, Essex: Pearson Education Ltd. ISBN 0-130-88890-7. Additional tailor-made readers and exercise descriptions and copies of PowerPoint slides.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
32	22	0	0	16	46	4

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Individual assessment based on a written test (closed book examination (marked), partly structured and partly with short open questions) (weighting 60%).
Assessment of the application of the knowledge in the Case Study (visualization and usability aspects) (weighting 40%).

Note(s)

Case Study			
Module: 5-10		Co-ordinating staff: Drs. B.J. Köbben	
Start:	05-01-2009		
End:	26-06-2009		
Level: M			U09-GFM-145

Introduction

The task of the Case Study is to develop a school planning system that can be used to evaluate the current public primary schools and to plan the location of new schools. The full requirements will be listed a Requirements Document, some of these will be:

- The system is to be used on the Intranet of the municipality
- It should use Open Standards (as set by the W3C and the OGC), wherever possible
- It should be usable for a non-specialist, i.e. someone with only basic computer skills and no special GIS training (e.g. the Head of the Public School Board)

We do not expect GFM3 students in the short period available (about 18 days) to actually build a full-fledged SDI. We will concentrate on practicing the use of GIS, Geospatial Database and dissemination and visualisation techniques that deploy wherever possible Open Standard interfaces to give access to spatial information across system boundaries. SDI is a broad concept and numerous different definitions exist. For the purpose of this case study we use a narrow, technical definition of an SDI as "a multi-levelled, scalable, and adaptable collection of services, which are interconnected across system boundaries via standardized interfaces. Those services enable users from different application domains to gaining a seamless access to spatial in-formation and geo-processing resources."

Contents

The use case is that of a planner that has to determine possible locations for schools within the Enschede municipal boundary. The students will NOT "play the role" of this planner, but that of the developer of the system(s) and (parts of) the geodata that provide the use case infrastructure to this planner. The emphasis is on the data infrastructure, which should provide the planner with appllications and data so that s/he should be able to use a simple, platform-independent interface (ie. a web browser) to a spatial application. The interface of this application should be browser-based, designed in a user centric manner, providing correct visualisations.

Objectives

The main objective of the case study is that students build upon, apply, and get a thorough working knowledge of the subjects covered in modules 1-10. This objective should be achieved by having the students build a coherent system for spatial data acquisition, storage, access, analysis and dissemination, that complies as much to SDI qualities and standards as can practically be implemented with the available resources.
Deliverables are:

- The system (on the ITC Intranet). All functionality should be linked from a 'home page' in a WWW site.
- A written technical report on the Case Study activities

Prerequisites

Modules 1-4

Recommended Knowledge

Not applicable

Hardware and Software Requirements
Windows PC with acccess to PostgreSQL DBMS and PostGIS spatial extensions, University of Minnesota Mapserver, ArcGIS, Python and a Javascript enabled webbrowser.

Teaching Materials
Case Study description; Requirements Document; Software manuals

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
0	0	0	0	152	0	0

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
The Case Study work as a whole (on the basis of the deliverables) will be assessed with a mark of "Completed" or "Not completed" assigned to module 12.

Note(s)
The usability of the Case Study system and the appropriateness of the geovisualization will also contribute for 40% to the overall mark for GFM M Module 10. See that module description for more information.

Programming Skills II			
Module: 5-10		Co-ordinating staff: Dr. O. Huisman	
Start:	05-01-2009		
End:	08-05-2009		
Level: M			U09-GFM-137

Introduction

The main objective of this course component is to provide a working knowledge of programming in the Python programming language. Python is a General-purpose open-source computer programming language used by thousands of developers around the world, in areas as diverse as spatial modelling, internet scripting, user interfaces, product customization, and more. Using a variety of theoretical and applied examples from each of the modules, students will learn how to think in a structured, logical way. "Programming Skills" will be taught and exercised in the *first* and *second* week of each module, but not in the exam week of any module. It will be assessed through regular exercises as well as the Case Study work.

Contents

- solving equations with matrices
- plotting graphs
- image processing with PIL
- processing hyperspectral data
- database connectivity with Python
- accessing data via the web
- accessing WMS and WMF
- geoprocessing using ArcGIS
- and more…

Objectives

After completing this course component students should be able to:

- Think analytically about a computational problem
- Formulate algorithms, which solve a given (simple) problem
- Create computational solutions for a given problem using Python
- Apply object-oriented techniques to model spatial phenomena
- Provide computational functionalities via the Web.

Prerequisites

Programming Skills I

Recommended Knowledge

Basic programming

Hardware and Software Requirements

The Python programming environment, plus additional modules.

Teaching Materials

- The book How to Think Like a (Python) Programmer, Allen Downey, Green Tea Press, 2007.
- Lecture notes and slides, available via Blackboard
- Exercises and puzzles, distributed via Blackboard.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	24	0	0	0	12	12

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Students are required to submit completed exercises at the end of each module. The mark allocated for this course component will be integrated into the Case Study mark.

Note(s)

Advanced Topics and Master Skills			
Module: 11		Co-ordinating staff: Dr. N. Hamm, Dr. C.P.J.M. van Elzakker	
Start:	18-05-2009		
End:	05-06-2009		
Level: M			M09-GFM-113

Introduction

This module is intended to allow course participants to further deepen their knowledge in the scientific fields covered by the Departments of Geo-Information Processing (GIP) and Earth Observation Science (EOS) and to enhance their professional master skills.
In terms of scientific content, course participants will have the option to choose one out of two alternative topics, one co-ordinated by a staff member of the GIP Department and the other co-ordinated by a staff member of the EOS Department.
The scientific topics will be embedded in a learning mode which is dedicated to the development and practice of professional master skills, such as information acquisition, critical reading, problem analysis, project management, technical report writing and presentation. Foundations for such master skills will make up the general part of the module, offered to all participants.

Contents

The alternative contents will be proposed shortly before the start of Module 11, in order to be able to take into account the latest developments in the disciplines and spatial data infrastructures, as well as the availability of capable staff.

Objectives

Main objective: allow course participants to gain more specialist knowledge in specific areas of geoinformatics, in relation with SDI and to enhance their professional master skills, also in preparation of the execution of the Individual Final Assignments.

Prerequisites

Modules 1 – 10 of the GFM.3 course.

Recommended Knowledge

Not applicable

Hardware and Software Requirements

Standard PC with standard applications in cluster

Teaching Materials

Various handouts, lecture-notes and exercise descriptions.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
16	16	0	0	36	18	2

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
The performance in the module will be assessed based on reporting assignments.

Note(s)

Individual Final Assignment preparation, Excursion			
Module: 12		Co-ordinating staff: Ir. R.L.G. Lemmens	
Start:	08-06-2009		
End:	26-06-2009		
Level: M			M09-GFM-114

Introduction

During the previous modules, the students gained knowledge about Geoinformatics with an emphasis on solving design problems making optimal use of operational technology relevant for providing core geo-spatial data and information. The course graduate will be able to work at a professional level in geoinformation production including the giving of support to the design and set-up of technological components of a spatial data infrastructure.
This module deals with the preparation of an Individual Final Assignment (IFA) which should reflect (parts of) the aspects mentioned. At the end of the module the students will submit a proposal which is created under the guidance of a supervisor and which will be the basis of the IFA.

The choice of an IFA topic is the responsibility of the student in consultation with the staff. For certain topics the material may be provided by ITC. If students prefer to work on a topic of the home country it is their own responsibility to obtain the necessary material.

Contents

- The students have to write a proposal which is related to a relatively restricted problem from a realistic situation through the application of skills and techniques learnt in the course. Real work environment, reflecting home organisations, should be included, e.g., SDI components, data collection problems, solving a problem in an organisation, e.g., in the Netherlands or nearby countries, A number of IFA's might be complementary to form a complete project.
- A one week study trip to professional organisations in Europe.

The co-ordinating staff will provide a general framework for the IFA.

The IFA proposal should:

- Identify and select a relevant topic.
- Define objectives and methods or techniques to be used.
- Indicate planning of activities and resources required.
- Indicate the form of the final IFA product.

Remark: One week of this module will be spend on finalising the case study (see description "Case study" in this study guide).

Objectives

The student must be able to:

- Define and plan a project to solve a real life problem related to the course content.

Prerequisites

Successful completion of the taught part of the course.

Recommended Knowledge

Knowledge and skills obtained in preceding modules.

Hardware and Software Requirements
Hardware and software used during the modules 1 to 11 or with authorisation of the IFA supervisor.

Teaching Materials
All lecturing materials etc used during preceeding modules and additional literature available in the library.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
4	0	0	40	80	0	0

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
The proposal has to be completed in time and it has to be accepted by the supervisor(s).

The case study is assessed and the indication completed or not completed will be on the course record for this module.

Note(s)

Individual Final Assignment			
Module: 12-15		Co-ordinating staff: Ir. R.L.G. Lemmens	
Start:	29-06-2009		
End:	28-08-2009		
Level: M			M09-GFM-115

Introduction
The Individual Final Assignment (IFA) has to be completed at the end of the Master course. The students have to solve a relatively restricted problem from a real life situation through the application of skills and techniques learnt in the course. In this way the students have to demonstrate that they have achieved the objectives of the Master course. The topic of the assignment must be related to the content of the course.

Contents
The student executes the project that is defined in the proposal which is written and discussed in module 12.

Two-weekly individual progress reports and progress meetings with the supervisors will monitor the progress on the IFA. The final outcome will be a report (hardcopy and/or CD-Rom) as well as an oral presentation and defence.

Objectives
The student must demonstrate independently his or her competence in the practical application of the earlier taught course topics and in professional problem solving.

The student must be able to:
- Define, plan and execute a project to solve a real life problem related to the course content.
- Apply methods and skills learnt in the course.
- Prepare a concise technical report.
- Orally present and defend the work done.

Prerequisites
Successful completion of the taught part of the course.

Recommended Knowledge
Knowledge and skills obtained in preceding modules.
Programming

Hardware and Software Requirements
Hardware and software used during the modules 1 to 12 or with authorisation of the IFA supervisor.

Teaching Materials
All lecturing materials etc used during preceeding modules and additional literature available in the library.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
20	0	0	0	331	0	0

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

An IFA Assessment Board will carry out the individual assessment based on the IFA report, a presentation and oral defence.

The assessed aspects are:
- Problem recognition and solving.
- Work planning and organisation.
- Skills in GI-science and earth observation.
- Independent working.
- Critical and professional thinking.
- Final product.
- Presentation and defence.

Note(s)

ITC Assessment Regulations

EA/4268

ITC REGULATIONS FOR COURSES LEADING TO AN ITC MASTER DEGREE

- September 2008 -

These ITC Regulations for the Master degree courses were approved by the Rector and the Academic Board on 17 September 2008. These regulations apply to all Master degree courses commencing September 2008 onwards and replace all former ITC Regulations for the Master Degree Courses.

1. Range of application

1.1 These assessment regulations apply to all courses leading to an ITC Master degree, starting from September 2008 onwards and replace all previous ITC Regulations for the Master Degree Courses.

1.2 The Master course can be an ITC course only (fully taught at ITC) or joint course (fully taught by one or more of ITC's partners or partly by the partner and partly by ITC). The course can be taught fully face-to-face or be a combination of face-to-face and distance components. In all cases, ITC monitors and assures the quality of the whole Master course.

1.3 In most cases where the Master course is taught in conjunction with a partner, the two institutes will agree upon new procedures which may take precedence over these 'ITC regulations for courses leading to an ITC Master degree'. The Course Director of the course concerned will inform the participants which assessment regulations and procedures apply.

1.4 In all cases that are not dealt with in these rules, the Course Director of the course concerned will decide upon an appropriate course of action.
Disputes about the interpretation of these regulations shall be referred to the Rector of ITC, who will determine the interpretation and action that should be taken.

1.5 In exceptional circumstances, the Academic Board, Degree Assessment Board, Head Education and/or Course Director may deviate from these regulations, but only with the approval of the Rector.

2. Management, structure and organization of the Master course

2.1 The Master course is organized into 15 modules[1] and one or two starting weeks for introductory and remedial activities. Some 10 modules consist of coursework including lectures, tutorials, practical work, case studies, project work, assignments and self-study. The remaining modules consist of an extended group project of two modules duration and an Individual Final Assignment (IFA) of three modules duration.

2.2 The duration of the course is 12 months fulltime. Participants may spread the modules over a maximum of three and a half years.

2.3 The formal curriculum of the Master course has been approved by the Academic Board.
Responsibility for detailed development and implementation of the approved course rests with Head Education, who delegates this responsibility to the Course Director.
Responsibility for quality assurance of the course rests with the Academic Board.
The Degree Assessment Board decides on the eligibility of the Master participant to receive the Master degree.
(See also the appendix 'Bodies and persons involved in management and quality assurance of the Master course').

2.4 During and at the end of the course, a participant's competence in the field of study will be assessed through tests, examinations and/or assignments (in written, oral and/or practical form) and/or based on participation. Assessments will be used to:

- Provide feedback to participants so that they may improve their performance (formative assessment), or,

[1] A module consists of related subjects and has duration of 3 weeks. Courses may contain project-oriented elements of two or more combined modules.

- Grade participants' work with a mark or quality description on a scale which indicates their competence in the field of study (summative assessment).

Before any assessment, participants shall be told which of the above two functions applies.
These regulations describe the conditions and procedures concerning summative assessments.

2.5 At the beginning of the Master course each participant shall receive a study guide that contains:

- Descriptions of the content of the course and modules
- A copy of these regulations
- The name of the Master degree to be received on successful completion of the course
- The course-specific conditions relating to that Master degree
- Which module assessments will result in a mark and which modules in 'completed/fail'.

2.6 The relationship between mark ranges, 'completed / fail' and grades is as follows:

Mark:	**Grade:**
90 - 100	Excellent
80 - 89	Very good
70 - 79	Good
60 - 69	Pass
00 - 59	Fail
'completed'	Pass or higher
'fail'	Fail

3. Admission to the Master course and exemptions

3.1 Applicants who meet the entry requirements, as stipulated in the current course brochure, may be registered for the Master course at the discretion of the Course Director.

3.2 Participants may be given exemption for a module of the course when they have shown they have already mastered the content of the module. An exemption for a module may lead to direct admission to the next module or to exchange of the module for a module in another course. Exemptions are subject to the approval of the Degree Assessment Board (and in case of exchange for a module in another course, approval of the Course Director of that course).

3.3 Exemption for a module will be given when this module was successfully completed by the participant:

(1) As part of another course in the same ITC domain as the Master course and
(2) No longer ago than three and a half years before the participant is expected to complete the Master course.

At least 50% of the Master course has to be taken to be eligible for the Master degree. Therefore, exemption can be given for a maximum of seven modules.

Requests for exemption that do not meet these conditions will be considered on an individual basis, at the discretion of the Degree Assessment Board. In such cases, exemption can be given for a maximum of five modules.

Exemption can never be given for (part of) the Individual Final Assignment.

3.4 In exceptional cases, a participant may also exchange a module of which the content has not been mastered for a module given in other courses, provided that the Course Director of that course approves. This is up to a maximum of two modules and subject to the approval of the Degree Assessment Board of the own Master course and of the Course Director of the receiving course.

3.5 Rules 3.2, 3.3 and 3.4 concerning exemptions do not apply to joint courses and other cases where ITC has an agreement with a partner institute that students who have successfully completed a specific curriculum in the partner institute can be given direct admission to a later part of the Master course.

4. Assessment of modules (excluding IFA)

4.1 Organization of module assessment

4.1.1 Each module will be assessed by means of a test, examination, assignment and/or based on participation. More than one assessment per module is allowed but must result in a single module mark (0 - 100) or 'completed / fail'. For combined modules (e.g. core modules, Individual Final Assignment), one overall assessment is allowed.

Up to four modules in the course may be assessed by 'completed / fail'. All other module assessments must result in a mark.

4.1.2 One overall assessment for combined modules is allowed. However, for admission to the Individual Final Assignment (see rule 5.2.1) and for the calculation of the average of all modules (see rule 6.2), the result obtained for combined modules will be given to each separate module.

4.1.3 Participants shall be informed of the date, subject, objectives and form of the assessment (practical, written, oral or computer-based, open or closed book), at least one week before an assessment.

4.1.4 The maximum duration of each assessment shall be as follows:

Written theoretical exam	3 hours
Computer-based theoretical exam	2 hours
Practical assignment	determined by the Course Director
Oral theoretical or practical exam	45 minutes

Participants shall be informed at the start of each assessment of:

- the duration of the assessment;
- if there is a choice, the number of questions to be answered;
- the weight of each question;
- whether books and/or notes may be used.

Two staff members must be present at an oral assessment.

4.2 Feedback to participants and re-sits

4.2.1 Participants shall be informed, individually, of the results of an assessment by the staff responsible for the assessment or by the Course Secretary, normally within two weeks of an assessment. The marks awarded for each question or assignment will be made known to each participant.

4.2.2 Marked scripts shall be shown to participants so that they may know the strengths and weaknesses of their answers. Answers to questions and results of assignments shall be reviewed in a class session, through the distribution of answer sheets or through comments on scripts. Staff responsible for the assessment is required to give an explanation of the marks awarded.

Scripts shall be retained for at least one year after the results are officially recorded.

4.2.3 The following rules apply to re-sits:

(1) Only those participants who fail an assessment at the first attempt (i.e. who achieve a mark less than 60 or 'fail') may re-sit that assessment. Only one re-sit per assessment is allowed.
(2) Participants who re-sit an assessment may obtain only a maximum mark of 69 (or PASS grade) or 'completed'.
(3) The previous mark or 'fail' will only be superseded when participants achieve a higher mark or 'completed' in the re-sit.
(4) Only the final grade will be shown on the Course Record or Certificate, without any indication whether the final grade was obtained through a re-sit or not.
(5) Participants who have failed due to serious circumstances (at the discretion of the Course Director) can apply for a new assessment, provided they have reported their circumstances in writing to the module coordinator or staff member responsible for the assessment before the scheduled assessment time.

4.2.4 In the case of practical assignments of long duration (practical exercises, a case study with fieldwork) the possibility of repetition can be considered only in exceptional circumstances and subject to approval by the Course Director.

4.2.5 A participant not attending a scheduled assessment, not completing an assignment or not presenting the required work within the specified time, will be considered as having failed. The participant will be given a 'fail' or a mark of 40 (or the lowest mark, if lower than 40, scored by the other participants on this assessment). If an acceptable reason (at the discretion of the Course Director) can be offered, the participant can apply in writing for a new assessment or extension of the deadline for submission of the assignment.

4.2.6 In case of plagiarism or other types of fraud, the participant(s) concerned will be considered to have failed and a mark 0 (zero) will be given (see also rule 8.5).

4.2.7 The grade sheets managed by the Course Secretary are the official record of the results of assessments. In case of discrepancies between this official record and marks and grades presented to participants in other ways, the marks and grades in the official record apply.

5. Individual Final Assignment

5.1 The Individual Final Assignment and report

5.1.1 The IFA period focuses on the application of knowledge, methods and techniques in the subject of the course to the task performed or to the problem investigated. The IFA work requires that the Master participant:

(1) Presents a draft IFA proposal (approx. 2 pages) to the Course Director as required by the course. Proposals (prepared in discussion with members of staff) must be related to geo-information and fall within the domain of the course and the chosen stream (i.a.).

(2) Prepares a final IFA proposal (approximately 5 pages), in consultation with the supervisor(s), to be submitted to the supervisor(s) before the deadline set by the Course Director.
(3) Carries out the IFA plan and reports on progress to the supervisor(s) according to an agreed schedule for the IFA and preparation of the IFA report.
(4) Makes oral presentations to staff and participants on the nature and progress of the IFA, when and as required by the Course Director.
(5) Prepares and submits the IFA report and presents and defends the IFA report when and as required by the Course Director.

5.1.2 The IFA work will be assessed on two occasions:

(6) The final IFA proposal, leading to approval of the proposal or to disapproval and an official warning in writing (see rule 8.1).
(7) The IFA report and oral examination.
(8) In addition to these two formal assessments the participant will receive feedback on his/her performance from the supervisors.

5.1.3 A participant not presenting the (draft) IFA proposal, not submitting the IFA report or not attending the final oral examination within the specified time, will be considered to have failed. Only in exceptional cases, and for reasons beyond the control of the participant (at the discretion of the Course Director), the participant may apply in writing for a new opportunity to meet the above requirements.

5.1.4 The IFA report, approximately 30 pages of text (approximately 350 words per page and presented in the standard ITC format for IFA reports), excluding appendices, shall constitute an ordered and logical description of the IFA. This includes the task performed and/or problem investigated, the applied knowledge, methods and techniques, the way they are executed and the evaluation of the results.

5.1.5 The IFA report may describe work done in conjunction with a supervisor or any other person, but the extent of the participant's personal contribution must be certified by the supervisor concerned.

5.1.6 With the explicit approval of the supervisor a participant may be permitted to incorporate in his/her IFA report a limited amount of unpublished work undertaken by the participant prior to the start of the Individual Final Assignment. A participant may not incorporate in his/her IFA report material which has been submitted for achieving the award of a degree from any other educational institution.

5.1.7 The source of any photograph, map, or other illustration shall be indicated, as shall the source, published or unpublished, of any material not resulting from the participant's own work.
If material from other work is incorporated verbatim, without proper acknowledgement of the source (plagiarism), the IFA Assessment Board may decide not to assess the IFA. This means that the Master degree cannot be awarded. (See also rules 8.3 and 8.5.)

5.2 Admission to the IFA period

5.2.1 For admission to the Individual Final Assignment, at least all but two of the previous modules (see rule 6.2 to see which modules are to be included) must have been successfully completed and no mark below 50 is allowed. The Academic Board may set additional requirements, which must be described in the Study Guide.

5.2.2 A participant who is not eligible for admission to the IFA, may however be allowed to continue with an individual special project (assessment will result in 'completed' or 'fail'). At the end of the course, the participant cannot be awarded a Master degree but will receive a Certificate.

5.2.3 The Course Director will assess the eligibility to the IFA period. He/she will also assess the IFA proposal and presentation by the participant or delegate this to an IFA Admission Committee.

5.2.4 When the participant is eligible to the IFA but the Course Director and/or the IFA Admission Committee is of the opinion that the IFA proposal does not have the required level, the participant gets one week to develop and write a better proposal. If still not satisfactory the participant will receive an official warning of the Course Director (see rules 8.1 and 8.2) but may still continue the IFA work and has still access to the IFA examination.

5.3 Supervision of the IFA

5.3.1 Based on the draft IFA proposal and in consultation with members of staff and the Master participant, the Course Director shall recommend a primary and secondary supervisor to the supervisor's department(s). Supervisors are appointed by the management team of the department.

5.3.2 The two supervisors shall divide the supervision tasks and make a supervision plan and meeting schedule with the participant.

5.3.3 Supervisor(s) shall:

(1) Guide the participant in the formulation of the final IFA proposal.
(2) Establish a schedule of supervisory meetings with the Master participant (on an average once per fortnight). Additional meetings may be arranged by agreement.
(3) Provide general advice and guidance on the execution of the IFA
(4) Provide feedback on draft written work, normally within five days of submission.
(5) Forward, where appropriate, any comments on the performance of the participant to the Course Director.
(6) Inform the Course Director when the progress of a participant gives cause for concern so that action can be taken in accordance with these regulations (see rules 8.1 and 8.2).

5.3.4 If a Master participant considers that he/she is not receiving the quality of supervision required in the regulations, the participant should report this to the Course Director.

5.3.5 Replacement of a supervisor may be considered if the subject of the Individual Final Assignment is found to be outside a supervisor's area of expertise, or at the request of the supervisor and/or of the participant.

5.4 Submission of the IFA report

5.4.1 The participant must submit a well-organized copy of all digital files associated with the IFA work on DVD, and a hard-copy of graphic output, at least one week before the examination date or as specified by the Course Director.

5.4.2 ITC will produce sufficient printed copies of the IFA report, including two for the participant. The participant must bring one of his/her copies of the IFA report to the oral examination.

5.4.3 One copy of the IFA report will be sent to each member of the IFA Assessment Board. The Institute will retain two bound copies if a degree is awarded, one of the copies being lodged with the Institute Librarian and the second copy in the course archive.

5.4.4 Where work submitted has been executed in cooperation with others, the supervisor must submit a written statement to the IFA Assessment Board indicating the extent of the participant's share of the work.

5.5 IFA examination

5.5.1 For the examination of the IFA, the Course Director nominates and the Degree Assessment Board approves a separate IFA Assessment Board for each participant. The IFA Assessment Board is accountable to the Course Director.

Each IFA Assessment Board has 2 to 3 members: (one of) the supervisor(s) of the participant, a professor or associate professor in a relevant discipline (chair) and, if needed, one other staff member of the ITC.

5.5.2 The IFA examination consists of the assessment of the IFA report and the oral examination. The oral examination is the defence of the IFA work that may be preceded by the participant presenting the results of his/her Individual Final Assignment. The oral examination has a maximum duration of one hour.

5.5.3 The Course Director assigns a date for an oral examination and informs the participant of this date at least three weeks in advance.

5.5.4 All members of the IFA Assessment Board shall read and assess the quality of the Individual Final Assignment report as an ordered and logical exposition of the application of knowledge, methods and techniques in the subject of the course to the task performed or to the problem investigated. A minimum of two members of the IFA Assessment Board must be present at the oral examination. (In case the ITC (associate) professor can not attend, Head Education will appoint another ITC (associate) professor to replace him or her.) They shall assess the participant's competence in the professional field, problem-solving skills and practical orientation.

5.5.5 The oral examination is open and will be announced as such.
In exceptional cases the Course Director can decide to have the defence of individual participants closed to observers other than ITC staff.

5.5.6 On the basis of the assessment of the participant the IFA Assessment Board shall take one of the following decisions:

(1) That the IFA is satisfactory. One single mark is given.
(2) Subject to minor corrections (that can be implemented within three working days and implemented before the official end of the course) in the IFA report, the IFA is satisfactory. One single mark is given, subject to the corrections in the IFA report being made.
(3) The IFA is not satisfactory and is given the FAIL grade.

5.5.7 No changes may be made in the IFA report after submission for the IFA examination, only an errata list may be added. If the IFA Assessment Board requires minor corrections to the report, these, and only these, corrections must be made and must be checked and approved by one of the supervisors. In all other cases changes can only be made when the report is to be re-examined by the IFA Assessment Board.

5.5.8 In exceptional cases extension to the IFA work may be given, but only before the IFA examination and only when:

(1) Funding for the extension is available, and
(2) The main cause of the unsatisfactory level of the IFA has been beyond the control of the participant (see 5.1.3), at the discretion of the Course Director.
(3) The participant will take the initiative and apply in writing for extension. If the Course Director is of the opinion that condition 2 is met he/she will forward the request to Head Education for decision.

5.5.9 Extensions have a maximum duration of one month. Extensions are only allowed when the participant stays at ITC or, in case of a joint course, at the institute of the partner.

This does not apply to participants who study part-time. They are allowed to work on the IFA in the home organization and since the Master course may be spread over a period of maximum three and a half years (see rule 2.2) they may work on the IFA until about a month before the end of the three-year period. In such cases, no extensions are possible.

5.6 Access to the IFA report

5.6.1 The primary function of the Institute is the development and dissemination of knowledge. IFA reports are lodged with the Institute Librarian and shall be made available for consultation, inter-library loan and photocopying.
For reasons of commercial confidentiality, access to digital files may be subject to restriction.

5.6.2 Any staff member who publishes results from an IFA report is obliged to make a proper reference to the Master participant's work.

6. Master degree assessment

6.1 On the basis of the assessment results of the participant, the Degree Assessment Board decides whether the participant will be awarded the Master degree,.

6.2 For the award of a Master degree the average of all module marks must be at least 60, no more than 2 modules may have a mark below 60 and no module mark below 50 is allowed. This implies that the Individual Final Assignment must have a mark of at least 60.

Only results of modules that are part of the formal curriculum of the Master course are included in the calculation of the average and counted for the number of marks below 60 and below 50. Therefore results of a module that is taken in addition to the formal curriculum or in exchange for a module of the formal curriculum for which exemption was given will not be included. However, a module that was taken in exchange because of a reason other than exemption (see rule 3.4), is (only for the application of this rule 6.2) considered as part of the formal curriculum.

When a module is assessed with 'completed', this will not be included in the average. When a module is assessed with 'fail', this will be counted as a mark of 50.

If results of modules were obtained more than three and a half years before the end of the course, then the validity of these modules must be confirmed by the Degree Assessment Board (see rule 3.3.).

6.3 To be entitled to receive a Master degree 'with distinction' the average of all module assessments (see rule 6.2 which modules are to be included) must be 80 or above. No marks below 70 or 'fails' are allowed and the Individual Final Assignment must have a mark of 80 or above.

Participants who have taken 11 or fewer modules of the formal curriculum (max. three exemptions or exchanged modules) are not entitled to receive a Master degree 'with distinction'.

6.4 The Degree Assessment Board shall take one of the following decisions:

(1) That the IFA and overall course performance of the participant are satisfactory. The degree of Master shall be awarded.
(2) That the IFA and overall course performance of the participant are such that the Master degree shall be awarded 'with distinction'.
(3) That subject to minor corrections in the IFA report, the IFA and overall course performance are satisfactory. The degree of Master shall be awarded subject to the corrections in the IFA report being made before the official end of the course.
(4) That the IFA and/or overall course performance are not satisfactory. The degree of Master shall not be awarded.

6.5 In case the Degree Assessment Board decides that the Master degree shall not be awarded, the participant will receive a Certificate.

7. Awards and certification

7.1 A **"Master Degree"** (with Course Record) will be awarded to a participant who has been officially admitted to a Master course (as approved by the Academic Board) and has fulfilled the assessment requirements of that course.

A **"Certificate"** (with Course Record) will be awarded to a participant who (1) has been officially admitted to a Master course but has not fulfilled the assessment requirements for that course, and (2) has fulfilled the assessment requirements of at least one summatively assessed module of that Master course.

The Certificate will mention that the participant 'has followed a course in Geo-information Science and Earth Observation' and the study load. Only the modules that have been completed and the modules in which the participant has participated for at least 80%, will be included in the study load.

A **"Certificate of Attendance"** (no Course Record) will be given to participants who have been officially admitted to a Master course, but have not fulfilled the assessment requirements of any summatively assessed module.

The Certificate of Attendance will mention that the participant 'has attended a course in Geo-information Science and Earth Observation' and the study load. Only the modules in which the participant has participated for at least 80% will be included in the study load.

No qualification other than 'with distinction' will be indicated on any Master degree.

7.2 Master degrees are issued under the responsibility of the Rector. Certificates and Certificates of Attendance are issued under the responsibility of the Course Director.

7.3 Signatures:

(1) Master degrees are signed by the Rector of the ITC and Head Education.
(2) Certificates and Certificates of Attendance are signed by the Course Director.

7.4 Master degrees and Certificates are accompanied by a Course Record, signed by the Course Director. The Course Record will show the period of study, the study load, the

titles of and marks or grades obtained for the modules that have been finished successfully or that the participant has participated in for at least 80% but not finished successfully.

The assessments 'completed' or 'fail' will appear as such in the Course Record.

7.5 Only the names and marks and/or grades of the modules that are taken are mentioned on the Course Record.
In case of exemption the number and not the name of the module will be mentioned (e.g. "Modules 1-3: exemption"). In case a new module was taken in exchange for a module for which exemption was given, the name of the new module will be mentioned also (e.g. "Module 3: exemption. Extra module: Database design"). In case of exchange of a module for another reason than exemption only the name of the new module will be mentioned (e.g. "Module 3: Database design").
The names of modules (and the results obtained) that are taken in addition to the formal curriculum of the course are also listed on the Course Record (e.g. "Extra module: Database design").

8. Early termination of the course

8.1 Where a Course Director and/or Head Education are/is of the opinion that a participant's progress gives cause for concern the participant shall be informed of the situation by the Course Director. Where a participant's performance is such that she/he is unlikely to obtain a Master degree without a significant improvement in performance, the participant shall be advised in writing by the Course Director of the situation and the implications. (Oral and/or written advice by the Course Director may not be given when the concern arises after the approval of the Individual Final Assignment proposal.)

8.2 In cases of obvious non-performance, a Course Director and/or Head Education may decide at any time that a participant must discontinue his/her course. Such a decision will not be taken without consulting the Degree Assessment Board and the participant having received one written warning and being given time to improve performance.

8.3 In case of fraud during an exam or in assignments, the participant(s) concerned will be considered to have failed and a mark 0 (zero) will be given.

In case of plagiarism in the submitted Individual Final Assignment, the IFA Assessment Board may decide not to assess the IFA. No extensions are possible then. This will mean that the Master degree cannot be awarded, the participant will get a Certificate.

8.4 In case of other types of misbehaviour, the Course Director will consider expulsion from the course.

8.5 In case of severe or repeated fraud, plagiarism or other types of misbehaviour, the Course Director, in consultation with the Academic board, will decide that the participant is expelled from the course.
Expulsion from the course means that the participant will not receive any certification.

8.6 ITC will use plagiarism detection software or other tools to detect fraud.

In submitting a text, the participant implicitly consents to the text being entered in the database of the detection software concerned.

9. Student appeal procedures

9.1 In case of problems of a general or structural nature in the course, the Student Association Board (SAB) may be consulted.

9.2 In the event that a participant disagrees with decisions taken by a lecturer or IFA Assessment Board, he/she may present this decision for reconsideration to the Course Director.
Where a Master participant finds that he/she is not receiving the quality of IFA supervision required in the regulations, the participant should also seek action from the Course Director.

Only in the event that a Master participant disagrees with decisions taken by the Degree Assessment Board he/she may present this decision for reconsideration to Head Education directly (see rule 9.3).

9.3 If not satisfied with the decision of the Course Director, the participant can seek action from Head Education. If Head Education rejects the complaint of the participant he/she will respond in writing describing the reasons.

9.4 If still not satisfied, participants have a final right of appeal with the Student Appeals Board. An appeal will only be accepted if:

- The formal methods of dealing with complaints (see rules 9.2 and 9.3) have not led to agreement,
- The appeal concerns the implementation of these 'ITC Regulations for the Master Degree courses' or the assessment of the Individual Final Assignment and
- The appeal has been made before the official end of the course. Appeals concerning the assessment of the IFA can be made up to a maximum of four weeks after the mark was received.

Appeals should be addressed in writing to the Chairman of the Student Appeals Board, through the Rector, and be accompanied by the argued written response to the appeal by Head Education.

9.5 Where unequal treatment of participants is claimed, copies of all relevant scripts shall be made available for review by those investigating the appeal.

9.6 The Student Appeals Board consists of three staff members to be appointed by the Rector. These staff members should not have been involved in the situation leading to the appeal. For appeals concerning the assessment of the IFA, staff members representing fields related to the subject of research will be invited to sit on the Student Appeals Board.

9.7 The Student Appeals Board will take a final decision on the appeal, after having heard all parties involved (including the Course Director) for relevant information. The decision on an appeal will be passed on to the Rector only if the Appeals Board cannot reach consensus. No further appeal will be possible.

9.8 The Student Appeals Board can reject the appeal or support it. In the latter case, the Appeals Board shall suggest remedial actions, which may include extension of the fellowship.

9.9 The Student Appeals Board should deal with the case within two weeks of receipt of the appeal. If necessary the fellowship will be extended for the duration of the appeal procedure. In case of an appeal concerning the assessment of the IFA, the fellowship may only be extended when the appeal is made before the official end of the course.

9.10 Support to a request for reconsideration or appeal concerning the assessment of the Individual Final Assignment cannot lead to overruling the assessment of the IFA by an IFA Assessment Board that is composed according to these regulations. Acceptable remedial actions do include a re-sit for the oral part of the IFA examination (only when a reason beyond the control of the participant has caused underperformance in the oral part).

Appendix 1

Bodies and persons involved in management and quality assurance of the Master course

The mentioned tasks and responsibilities must be carried out in accordance with these 'ITC Regulations for the Master degree courses'.

Rector

The Rector has the overall responsibility for all tasks of ITC.
The Rector has delegated the academic, quality and policy aspects of the educational programmes and courses to the Academic Board and the implementation of the programmes and courses to Head Education.
The Rector appoints the Head Education, Course Director and Student Appeals Board.

Scientific Council

The Scientific Council advices the Rector and Academic Board on the quality of education and research of the ITC. This responsibility includes:

- Advice on degrees offered by the ITC
- Advice on course curricula, including admission criteria.
- Advice on ITC's quality assurance system
- Advice on degree and assessment regulations, including these 'ITC Regulations for the Master degree courses'

The Scientific Council is a mainly external body; two third of the members are professors of Dutch universities.

Academic Board (AB)

The Academic Board is responsible for the quality of ITC's courses and for development of policy on education. This responsibility includes:

- Advice on the degrees offered by the ITC
- Approval of the curricula of the Master courses
- Approval of ITC's quality assurance system and monitoring of the implementation
- Advice on course-specific elements of the quality assurance system
- Approval of policy on education
- Approval of degree and assessment regulations, including these 'ITC Regulations for the Master degree courses'
- Acting as Degree Assessment Board

The Academic Board consists of the Rector (chair) and all full and visiting professors of ITC.

Head Education

Head Education is responsible for:

- Monitoring of the implementation of the Master course, ITC's quality assurance system and ITC's educational policy as approved by the Academic Board and the Rector. Head Education delegates the actual implementation to the Course Director.
- Coordination and implementation of supra-course aspects.

Course Director (CD)

The Course Director is responsible for:

- Implementation of the Master course, ITC's quality assurance system and ITC's educational policy, as delegated by Head Education
- Implementation of decisions taken by Head Education
- Day-to-day co-ordination and execution of the course.
- Counselling of participants in matters concerning their studies.

Degree Assessment Board

The Degree Assessment Board assures that participants who are awarded the Master degree have the required level.
This responsibility includes:

- Decision on deviation of the formal curriculum by individual participants
- Appointment of the IFA Assessment Boards
- Decision on award of the degree to individual participants

The Academic Board acts as Degree Assessment Board.

IFA Assessment Board

The IFA Assessment Board is responsible for assessment of the IFA report and oral examination of the participant on completion of the IFA work.

Student Appeals Board

The Student Appeals Board is a semi-permanent committee, which will be appointed by the Rector when an appeal from a participant is received.

Appendix 2

Examples

ITC Master Regulations

Structure of the course used in the examples: 10 modules of course work, 2 modules for a group project and 3 modules for the Individual Final Assignment. The assessment of modules 1 and 6 resulted in 'completed / fail'.

Admission to the Individual Final Assignment

5.2.1 For admission to the Individual Final Assignment, at least all but two of the previous modules (see rule 6.2 to see which modules are to be included) must have been successfully completed and no mark below 50 is allowed. The Academic Board may set additional requirements, which must be described in the Study Guide.

4.1.2 One overall assessment for combined modules is allowed. However, for admission to the Individual Final Assignment ……. the result obtained for combined modules will be given to each separate module.

6.2 ……. Only results of modules that are part of the formal curriculum of the Master course are included in the calculation of the average and counted for the number of marks below 60 and below 50. Therefore results of a module that is taken in addition to the formal curriculum or in exchange for a module of the formal curriculum for which exemption was given will not be included. However, a module that was taken in exchange for a reason other than exemption, is ……. considered as part of the formal curriculum. …….

Examples of 4 participants:

Module	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11+12*	*13+14+15*
participant 1	*c*	*65*	*63*	*71*	*78*	*f*	*51*	*80*	*91*	*70*	*90*	
participant 2	*f*	*63*	*e*	*74*	*70*	*c*	*60*	*60*	*61*	*73*	*58*	
participant 3	*c*	*60*	*63*	*71*	*70*	*f*	*ee 43*	*78*	*90*	*82*	*71*	
participant 4	*c*	*60*	*63*	*71*	*70*	*f*	*ne 43*	*78*	*90*	*82*	*71*	

c = completed *e = exemption*
f = fail *ee = exemption, extra module*
ne = new module, exchange for other reason than exemption

Participant 1: admission to IFA

Participant 2: no admission to IFA

Participant 3: admission to IFA

Participant 4: no admission to IFA

Award of the Master degree

6.2 For the award of a Master degree the average of all module marks must be at least 60, not more than 2 modules may have a mark below 60 and no module mark below 50 is allowed. The Individual Final Assignment must have a mark of at least 60.

Only results of modules that are part of the formal curriculum of the Master course are included in the calculation of the average and counted for the number of marks below 60 and below 50. Therefore results of a module that is taken in addition to the formal curriculum or in exchange for a module of the formal curriculum for which exemption was given will not be included. However, a module that was taken in exchange for a reason other than exemption (see rule 3.4), is (only for the application of this rule 6.2) considered as part of the formal curriculum. When a module is assessed with 'completed', this will not be included in the average. When a module is assessed with 'fail', this will be counted as a mark of 50.

6.3 To be entitled to receive a Master degree 'with distinction' the average of all module assessments must be 80 or above. No marks below 70 or 'fails' are allowed and the Individual Final Assignment must have a mark of 80 or above.
Participants who have taken 11 or fewer modules of the formal curriculum (max. three exemptions or exchanged modules) are not entitled to receive a Master degree 'with distinction'.

4.1.2 One overall assessment for combined modules is allowed. However, …… for the calculation of the average of all modules (see rule 6.2) the result obtained for combined modules will be given to each separate module.

Examples of 5 participants:

Module	1	2	3	4	5	6	7	8	9	10	11+12	13+14+15
participant 1	c	65	63	71	78	f	51	80	91	70	90	80
participant 5	c	61	69	71	78	c	62	90	63	81	65	55
participant 6	c	70	87	75	90	c	90	80	95	68	80	90
participant 7	c	82	70	86	77	c	73	81	88	73	78	85
participant 8	e	e	e	ee 81	80	c	83	73	70	70	90	85

c = completed *f = fail* *e = exemption* *ee = exemption, extra module*

Participant 1: Average = $\frac{65+63+71+78+50+51+80+91+70+2*90)+(3*80)}{14}$ = 74.2

The Master degree will be awarded.

Participant 5: No Master degree will be awarded, since the IFA has a mark below 60.
The participant will receive a Certificate.

Participant 6: Average = $\frac{70+87+75+90+90+80+95+68+(2*80)+(3*90)}{13}$ = 83.5

The Master degree will be awarded. The participant will not receive the degree 'with distinction', since the mark of module 10 is below 70.

Participant 7: Average = $\frac{82+70+86+77+73+81+88+73+(2*78)+(3*85)}{13}$ = 80.1

The Master degree 'with distinction' will be awarded.

Participant 8: Average = $\frac{80+83+73+70+70+(2*90)+(3*85)}{10}$ = 81.1

The Master degree will be awarded. The participant will not receive the degree 'with distinction' since exemption was given for more than three modules.