

ITC STUDY GUIDE 2009/2010

**Master of Science degree and
Postgraduate diploma courses
in Geo-information Science and
Earth Observation for**

Applied Earth Sciences

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Master of Science course code : C09-AES-MSc-01
Postgraduate diploma course code : C09-AES-PG-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.

A major change will take place during your studies at ITC. From 1 January 2010 ITC will become a faculty of the University of Twente (UT). Hence, ITC students will receive an UT degree from that date onwards. ITC education, however, will continue to be offered at the present location of our Institute.

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 2009/2010 Postgraduate diploma and Master of Science degree programmes 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.

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 ITC staff is originating from more than 25 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 the Master of
Science degree and the
Postgraduate diploma
programmes**

1. Introduction to the Master of Science degree and the Postgraduate diploma programmes

1.1 Curriculum

Master of Science

The duration of the Master of Science (MSc) degree programme is 18 months.

The MSc degree programme in Geo-Information Science and Earth Observation consists of eight courses, each with a specific orientation:

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

At successful completion of the Master of Science degree programme, the student is able to:

1. Analyse problems encountered in professional practice and develop appropriate methods for studying and/or solving these problems.
2. Apply appropriate methods for collecting, acquiring and verifying spatial data.
3. Use geo-information science and earth observation to generate, integrate, analyse and display spatial data.
4. Evaluate and apply relevant and appropriate methods and models for data analysis and problem solving.
5. Apply research skills to formulate and carry out an independent research project.
6. Communicate and defend findings of thesis work.

These objectives at programme level are worked out into objectives at course and module level. For more information on these, please check the domain specific part of this study guide or the module descriptions.

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

Postgraduate diploma

The nine month Postgraduate diploma course 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.

Postgraduate diploma courses are offered in:

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

At successful completion of the Postgraduate diploma course, the student is able to:

1. Analyse problems encountered in professional practice and develop appropriate methods for studying and/or solving these problems.
2. Apply appropriate methods for collecting, acquiring and verifying spatial data.
3. Use geo-information science and earth observation to generate, integrate, analyse and display spatial data.
4. Evaluate and apply relevant and appropriate methods and models for data analysis and problem solving.

These objectives at course level are worked out into objectives at course and module level. For more information on these, please check the domain specific part of this study guide or the module descriptions.

The Postgraduate diploma course leads to a Diploma with the title:

"Postgraduate diploma in Geo-Information Science and Earth Observation"

1.2 Course Structure

All ITC courses are divided into three week periods (modules) or multiples of three weeks (blocks) in which one subject or related subjects are taught. The Postgraduate Degree programme is taught together with the MSc programme during the first nine months.

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. The first modules in all degree courses contain 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.

The Master of Science programme is split up in four *blocks*. The Postgraduate diploma programme is equal to the MSc programme during Block 1 and 2. MSc and PGD students follow these blocks together in class.

Figure 1

Structure of MSc and PGD programmes

Block 1 Principles of RS and GIS (4 modules)	Block 2 Scientific domain (6 modules)	Block 3 Research profile (5 modules)	Block 4 Individual MSc research (8 modules)
MSc programme →			
PGD programme →			

Figure 2

**Master of Science degree and Postgraduate diploma programmes
Structure in detail**

			MSc	PGD
Block 1	1	Introduction, Principles of RS and GIS, Application in domain		
	2			
	3			
	4			
Block 2	5	Domain modules, different per course (AES, GFM, GSIM, LA, NRM, UPM, WREM)		
	6			
	7			
	8			
	9			
	10			
Block 3	11	Research skills		Final assignment
	12	Advanced subjects		
	13			
	14	Research themes, MSc proposal		
	15			
Block 4	16	Individual MSc research	MSc thesis	
	17			
	18			
	19			
	20			
	21			
	22			
	23			

Block 1: Principles of GIS/RS

Block 1 is the common core of all ITC educational programmes. It teaches 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. Block 1 also contains an introduction to the course as a whole and the teaching approach, and a student advisor is assigned to each student.

Block 2: Domain

Block 2 is specific for the different courses within ITC MSc programme (AES, GFM, GSIM, LA, NRM, UPM, WREM). In this block the basic principles of the domain and application of GIS and RS in it are taught and deepened. Please look at the course specific parts of this study guide to find out more about the content of Block 2 in your course. Students need to select an MSc thesis topic in this block and work this out in an MSc pre-proposal. An MSc day and MSc fair are organised to support this.

Block 3: Research profile

Block 3 prepares the student for his/her MSc research by offering learning opportunities on research skills, advanced research tools and methods, and deepening of research topics.

It starts with a module on research skills. The module is similar for all courses. The objectives are common, but examples and cases are used from the scientific domain of each course. Two MSc supervisors are assigned to each student.

The second part contains "advanced topics". These topics go in-depth in a certain research method or tool. These have a more generic nature and are supposed to attract students from different domains. Students have to make a choice from these advanced topics, which match to their envisaged MSc thesis topic. Because of the advanced level, entry requirements may be defined for the advanced topics.

The third part of this block is assigned to the ITC research themes. Students have to formulate their MSc thesis topic within one of ITC research themes. In the last two modules students will study state-of-the-art knowledge and research in these themes in a group research assignment. Parallel to this, the student will work on his/her final MSc thesis proposal. The student has to make a choice for a certain research theme, based on his envisaged MSc thesis topic.

Block 4: Individual MSc research

In Block 4 the student works individually on his/her MSc thesis. It is required to have an approved MSc research proposal before entering this block. During this block there is interaction with the staff, PhD and MSc students of the research theme, for example in *capita selecta*. Each student will be assigned 2 MSc supervisors. Formal assessment will be given at the mid-term presentation and of course the final MSc exam (see MSc regulations).

1.3 Academic Profile

The academic profile of the MSc programme puts strong emphasis on the scientific discipline, a scientific approach, basic intellectual skills, co-operation and communication and the temporal and social context of research. The emphasis on doing research and/or designing or developing new methods or techniques depends on the application domain.

Multi-disciplinary research is an important focus for the MSc programme because (applied) research in practice seldom concerns one discipline but is more likely to be multidisciplinary. Students have to be prepared for that. Starting with a sound basis in their own domain they will be brought into learning situations in which students from different domains work together. It should be noted that most if not all research at ITC is

already multidisciplinary in nature. This is evident in the wide scope of expertise within departments, and the common denominator to carry out applied research contributing towards development related issues as specified in ITC's mission.

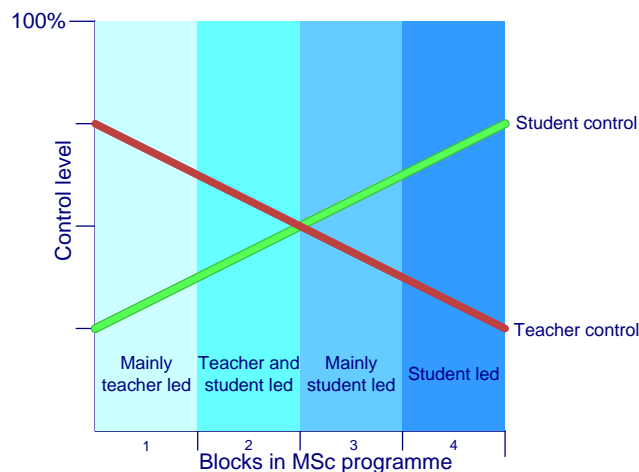
1.4 Teaching Approach

In their profession, the graduates have to apply knowledge and skills independently. The MSc programme is therefore focused at handing over the control of the learning process to the student. At the beginning of the programme, the teacher will have the main control and the programme will contain some choices, especially concerning preparation for the MSc research.

The choices should be motivated, fit to the envisaged research trajectory, and be accepted by the course director. During the programme the teacher role will develop towards the role of advisor. The student takes the lead in his/her own learning process by developing his/her own learning plan within the MSc framework and guidelines. The teacher supports this as a coach (while still passing on his/her experience).

Figure 3

Handing over control from the teacher to the student



Block 1: Mainly Teacher Led

In Block 1 the teacher takes the lead. He/she defines the content to be studied and learning tasks and exercises which have to be executed. Students can make limited choices between learning strategies and learning tasks. The number of contact hours between teacher and students is relatively large in this stage, mainly consisting of lectures and supervised practical exercises. Each student will be assigned a student advisor in Module 1 for advice on study related matters, especially the choice trajectory towards the MSc topic selection, but also for day-to-day problems, remedial self-study, etc. The student advisor is assigned for the whole MSc course.

Block 2: Teacher and Student Led

In Block 2 both the teacher and the student take the lead. The teacher defines the framework in which the student can make his/her own choices about study tasks. The amount of choice options varies across the different courses (or streams). The student has to start thinking about his/her MSc research topic and consult staff about its feasibility.

The number of contact hours between teacher and students is reduced in favour of group work and independent study and assignments.

Block 3: Mainly Student Led

In Block 3 the student takes control by choosing advanced subjects and a research theme which fit within his/her MSc thesis topic. The student works on the final version of MSc research proposal and consults his student advisor and other specialised staff about its feasibility and quality. The final version of the MSc research proposal has to be presented and defended by the student for the Thesis Admission Committee. The number of contact hours between teacher and student is further reduced to make room for independent study by the student. Two MSc supervisors (first and second) are assigned for MSc supervision at the beginning of Block 3.

Block 4: Student Led

In Block 4 the student works individually and independently on his/her MSc research project. This will be supported by meetings with the MSc supervisors and *capita selecta* meetings, organised by the research themes. The student is responsible for progress and quality of his/her own research project and its defence at the end.

The number of contact hours between teacher and students is reduced to a minimum in this period. It is therefore wise to look for peer support and peer review opportunities in this phase, which is offered in the research theme where staff, PhD and MSc students are together.

1.5 Roles within the Curriculum

Course Director

The course director is authorised by and accountable to the Head Education regarding development and implementation of all courses within a specific domain and their specialisations. The course director is responsible for execution of the courses, including logistic aspects, fieldwork, purchase of all materials, the administration of information regarding students and their study results, diplomas and course records, and course content archiving.

Course Secretary

The course secretary supports the execution of the course and the course director. She is the first point of contact for students requiring information regarding the course.

Module Coordinator

Each module is coordinated by a staff member. He or she is responsible for the organisation and execution of the entire module. The module coordinator can be contacted for information or questions regarding the module he/ she is responsible for.

Student Advisor

Each student is assigned a student advisor who can help him or her with study related problems and questions. In many courses, the course director has the role of student advisor.

Supervisor

Each MSc student will be assigned to a supervisor for the development of their research proposal and the execution of their thesis research.

Thesis Admission Committee

MSc students have to develop a research proposal for their thesis and defend this to the Thesis Admission Committee at the end of Module 10 of the MSc programme. The Thesis Admission Committee decides whether the research proposal is acceptable to ITC and complies with (inter)national standards. A positive decision of the Thesis Admission Committee grants the MSc student entrance to Block 4 of the MSc programme.

Thesis Assessment Board

The Thesis Assessment Board is responsible for the assessment of the MSc thesis at the end of the MSc degree programme.

Academic Board

The Academic Board, consisting of all professors of ITC, is amongst other tasks, responsible for the curriculum and quality assurance of education.

1.6 Study Load

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 EC credits represent the workload of an academic year 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 EC. The MSc course consists of 23 modules and three additional weeks of remedial teaching, catch-up activities and graduation ceremonies, totalling 118 EC. The Postgraduate diploma course consists of 12 modules and 1 week of remedial teaching, and catch-up activities, totalling 61 EC.

1.7 Opening Hours of 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 – 16:30

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

1.8 Starting dates of modules and holidays

Module number	2009 / 2010 / 2011
<i>Registration Master + MSc + PGD</i>	<i>Monday, September 14, 2009</i>
<i>Opening Academic Year</i>	<i>Thursday, September 24, 2009</i>
Module 1	September 28 through October 16
Module 2	October 19 through November 6
Module 3	November 9 through November 27
Module 4	November 30 through December 18 RS exam: Friday, 6 November 2009 GIS exam: Friday, 27 November 2009 re-sit exam RS: Wednesday, 9 December 2009 re-sit exam GIS: Wednesday, 16 December 2009
<i>Diēs Natalis ITC</i> <i>Christmas break</i>	<i>Thursday, December 17, 2009</i> <i>December 21, 2009 through January 3, 2010</i>
Module 5	January 4 through January 22, 2010
Module 6	January 25 through February 12
<i>MSc day</i>	<i>Wednesday, January 27, 2010</i>
Module 7	February 15 through March 5
Module 8	March 8 through March 26
<i>MSc research fair</i>	<i>Wednesday, March 10</i>
Module 9	March 29 through April 16
<i>Good Friday</i> <i>Easter Monday</i>	<i>April 2, 2010</i> <i>April 5, 2010</i>
Module 10	April 19 through May 7
<i>Queen's day</i> <i>Liberation day</i> <i>Ascension day</i>	<i>April 30, 2010</i> <i>May 5, 2010</i> <i>May 13, 2010 (+ May 14 ITC closed)</i>
<i>Catch-up week MSc & Master</i>	<i>May 10 through May 14</i>
Final Project PGD	May 10 through June 11
Module 11	May 17 through June 4
<i>Whitsun Monday</i>	<i>May 24, 2010</i>
Module 12	June 7 through June 25
<i>Closing week PGD</i> <i>PGD closing ceremony</i>	<i>June 14 through June 18, 2010</i> <i>Friday, June 18, 2010</i>
Module 13	June 28 through July 16
<i>Catch-up week MSc</i>	<i>July 19 through July 23</i>
Module 14	July 26 through August 13
Module 15 MSc proposal presentations + Master defences	August 16 through September 3 August 30 through September 3
<i>Closing week Master</i> <i>Master graduation</i>	<i>August 30 through September 3</i> <i>Friday, 3 September 2010</i>
MSc modules 16 through 23	September 6, 2010 through February 25, 2011
<i>MSc mid-term presentations</i> <i>Diēs Natalis ITC</i> <i>Christmas break</i> <i>MSc thesis submission</i> <i>MSc defences</i>	<i>November 1 through November 5, 2010</i> <i>Friday, 17 December 2010</i> <i>December 27, 2010 through January 3, 2011</i> <i>Monday, 21 February 2011</i> <i>February 28 through March 4, 2011</i>
<i>Closing week MSc</i>	<i>March 7 through March 11, 2011</i>
<i>MSc graduation</i>	<i>Thursday, March 10 and Friday, March 11, 2011</i>

Applied Earth Sciences

2. Applied Earth Sciences

2.1 Introduction

In our daily life we are continuously confronted with things and situations that have a direct link to earth resources as well as with related processes that take place in the environment where we live. The buildings in which we live and work are constructed with materials taken from the earth, the soil produces our daily food, and mineral resources provide fuel for our transport and cooking.

The other side of the coin is that the same processes that shape the environment in which we live, can be extremely destructive as well. Recent events, such as the tsunami in Southeast Asia and the earth quakes in Pakistan, Peru and Indonesia show that the forces in nature can have huge impact on the lives and livelihood of people.

We have developed a range of tools and techniques to make inventories of all the resources that are at our disposal and to plan and manage their use in the best possible way, not only for our own current situation, but also for future generations. These tools and techniques make it possible for us to use those resources wisely, foresee risks and plan accordingly. They are the subject of study in the courses on Applied Earth Sciences.

Natural disasters such as flooding, earthquakes and volcanic eruptions can occur all over the world. At the same time, many places on earth suffer from natural or man-induced land degradation, often with gradual but devastating effects, for example on food security. The assessment of how big the risks are and careful planning of precautionary measures are important issues to deal with. No place on this globe is 100% safe, and we have to come to grips with the vulnerability of the environment in which we live. This subject is central to the Applied Earth Sciences (AES) stream on **Geo-Hazards (GH)**.

In addition, when we construct infrastructure, put buildings in place or in other ways influence the natural environment we need to be sure that the constructions will serve the purpose for which they are created. We also have to make sure that they are strong enough to survive catastrophic events and do not have a negative impact on the environment. Spatial information can be used in engineering practices but with a clear focus on environmental impact and environmental integrity in a planning context. This is the focus of the AES stream on **Geologic and Environmental Engineering (GEE)**.

The utilisation of non-renewable earth resources such as oil and gas should leave future generations also the opportunity to develop and prosper in their own time. This means that the discovery of new earth resources is important. But also local expertise to discover and exploit these resources in a proper way that benefits society and does not harm the environment must be developed. This is the area of interest for the AES stream on **Earth Resources Exploration (ERE)**.

We trust that the courses in Applied Earth Science will provide you as course participants with all relevant knowledge and skills that will help to meet the aims and objectives as described for them, and that they will enable you to apply them in an appropriate and creative way.

Tom Loran, Course Director

*Applied Earth Sciences Courses, ITC
June 2009*

2.2 Objectives and competences

The main aim of the course in Applied Earth Sciences is to equip participants with the necessary knowledge and skills to use spatial information, Geographic Information Systems and Remote Sensing techniques in the context of problems that are related to the field of earth sciences. Emphasis is put on the meaningful and creative use of these tools and techniques from an earth science background, but with an open eye for other disciplines and scientific fields.

A number of generic competencies and skills that will be obtained during the course are:

- Application oriented problem solving;
- Able to work in teams with specialists of other disciplines;
- Continuous critical learning attitude, flexible, pro-active, have a vision;
- Ability to respond to changing demands and opportunities (from society and discipline);
- Ability to respond to developing theory as well as improved techniques;
- Confident communicator, both to peers as well as to a general public;
- Ability to act in various cultural environments.

For the Postgraduate diploma course the above will be applied to key tasks from the professional field. Throughout the course participants will be exposed to new tools and techniques, and will be encouraged to develop a critical understanding of their application.

Specific objectives for the Postgraduate diploma course are:

- Acquire practical knowledge and skills in using technology for spatial information handling
- Apply practical skills for analysing and solving of relevant development problems
- Carry out projects and assignments (group-wise and individual)
- Carry out technical reporting on the results of an Individual Final Assignment
- Communicate and present the findings of work done

The Master of Science degree course aims at developing academic skills and will prepare participants to individually carry out scientific research. Specific objectives for the MSc course, in addition to those shared with the Postgraduate diploma course, are:

- Acquire academic research skills in scientific reading, writing and reasoning;
- Apply research skills to formulate a research proposal;
- Carry out an individual research project;
- Apply up-to-date techniques in primary data acquisition and processing;
- Write an MSc thesis on the research projects and it's findings;
- Communicate and defend the findings of research work.

Three streams of specialisation

Within the Applied Earth Science course there are three streams or specializations. Each stream focuses on a certain area of the earth science domain. Streams that are currently offered as part of the course are:

- Geo-Hazards (GH)
- Geologie and Environmental Engineering (GEE)
- Earth Resources Exploration (ERE)

Specific objectives per stream

For each of the three streams a number of objectives can be identified which are briefly described below.

Geo-Hazards

Aim: This stream aims to strengthen capacity to apply spatial information and earth observation techniques in the identification, mapping and monitoring of geo-hazards and in the quantification of vulnerability and risk, in order to prevent and reduce damage done to people, their property and the physical resource base on which they depend.

Expected responsibilities: Study the occurrence and extent of natural disasters (volcanic eruptions, earthquakes, landslides, flooding and coastal hazards) as well as gradual degradation processes (erosion, desertification, salinization, land subsidence), including their distribution, frequency and intensity; Study susceptibility of society to the damage caused by these events and determine their environmental impact; Establish risk assessment methods, design hazard-warning systems and develop damage reduction scenarios. Develop spatially explicit land degradation control and restoration scenarios; Communicate with relevant stakeholders throughout the process of geo-hazard studies and communicate results effectively and efficiently

Geologic and Environmental Engineering

Aim: This stream aims to strengthen capacity to use spatial information and earth observation techniques in engineering practices but with a clear focus on environmental impact as well as awareness of environmental integrity in a planning context. This is done through planning and selection of sites for engineered infrastructure (e.g. dams, roads, waste disposal sites) considering costs and function, risks of damage to the infrastructure (e.g. by earth quakes and slope instability) and impacts of the infrastructure on the environment at large. The program looks at the reality of engineering practice in the environment, considering the entire process from data acquisition, analysis, modelling and assessment, prediction and monitoring.

Expected responsibilities: Develop alternative scenarios (from an earth science perspective) for locating engineered infrastructure and apply decision support systems (DSS) to optimise site selection; Use spatial information to predict and assess the impact of engineered infrastructure on the environment, consider these impacts in planning, model and monitor developments, and develop alternative scenario's and remedial action; Make creative use of analysis and modelling techniques such as (3-D) GIS and DSS, EIA (environmental impact assessment)

Earth Resources Exploration

Aim: This stream aims to strengthen capacity to apply earth observation and geoinformation techniques to explore and prioritize areas for exploitation of earth resources (considering costs, benefits and potential impacts on the environment). This is done through the investigation of mineral occurrences with exploration potential, making use of state-of-the-art techniques in GIS, remote sensing and modelling, with special attention for on-site and off-site environmental impact of extraction activities.

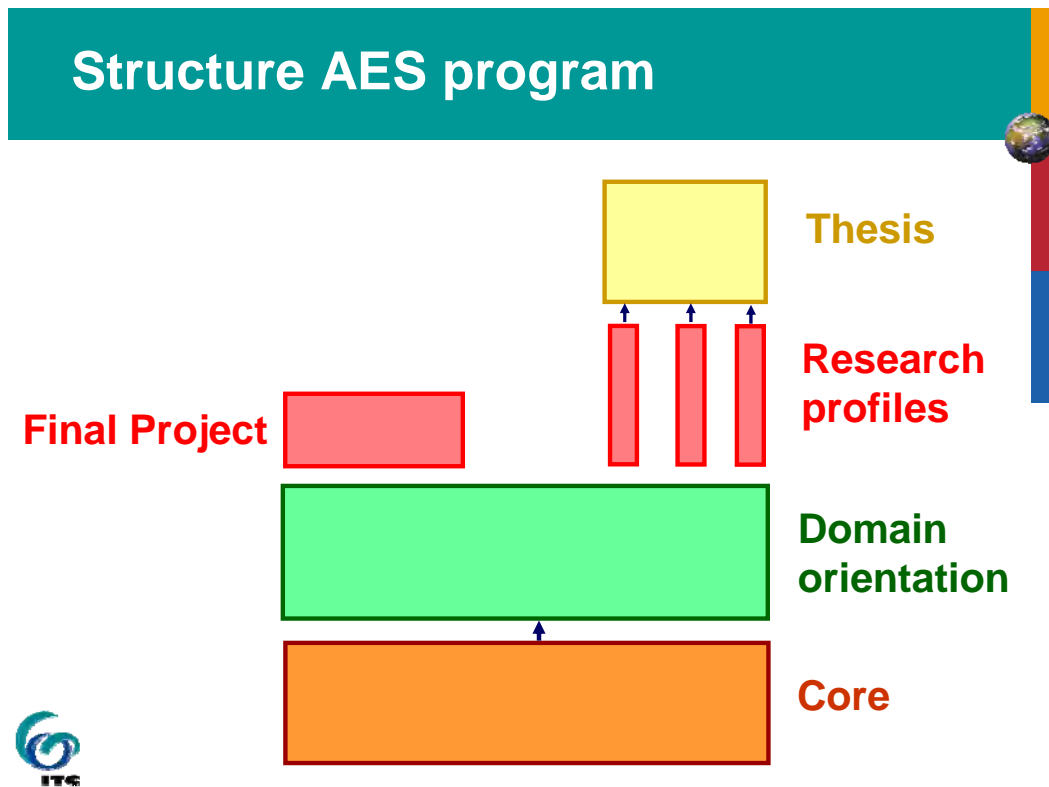
Expected responsibilities: Supply geological information to contribute within a multidisciplinary context including economic and environmental perspectives to prioritization of areas for mineral exploration. Define, collect, manage, process and analyze earth observation data as well as ground observations and geoinformation techniques to localize and quantify earth resources.

2.3 Curriculum of the Domain

The curriculum in Applied Earth Sciences (AES) courses in ITC aims at the application of Geo-Information Science and Earth Observation for problems in society that have an earth science nature. The emphasis in the AES courses is on dealing with development issues, ensuring that the participants develop a thorough appreciation of modern geoscience concepts and a good understanding of the management of spatial information. Emphasis will be on the use of remote sensing techniques and Geographic Information Systems; remote sensing methods will be used for the acquisition of all relevant datasets on earth resources, and GIS will be used for managing, modelling and analyzing these often large and complex data sets.

The Master of Science degree (18 months) and Postgraduate diploma (9 months)

Two courses are currently offered in Applied Earth Sciences: the 18-month Master of Science degree (MSc) course and the 9-month Post Graduate Diploma (PGD) course. The course program is divided in a number of blocks of which the first two are common to both the MSc and the PGD course, as is shown in the figure below.



Course outline Applied Earth Sciences 2009 – 2011

Core Modules

The first block deals with the **core modules** of ITC and includes lectures and exercises on the principles of GIS and remote sensing. These subjects are common to all ITC programs and are followed by participants in all other courses as well. The ITC core modules deal with the theory, tools and techniques of the technology that are used to collect, store, manage analyze and process spatial data and information. The program includes a lot of practical work as well as a number of larger assignments, and is concluded with an Individual Practical Assignment (IPA).

Domain Modules

The second block is a block that deals with the thematic content (or **domain orientation**) that is relevant for the AES program, and includes issues that are important in solving problems in applied Earth Sciences. Use is made extensively of the tools and techniques that have been presented in the first block. Within the domain of Applied Earth Sciences it is possible to choose from three specializations or streams: Geo-Hazards, Earth Resources Exploration and Geologic and Environmental Engineering.

The second block includes a number of common subjects which will be attended by all AES students because they are considered relevant for all three specializations. Besides that there are lectures and practicals which are more specifically aimed at the specializations that are available. The lectures and practicals do not strictly follow a modular structure, but are mixed and linked in time.

The second block contains a number of projects that stretch out over several modules. The projects are scheduled in such a way that taught subjects that are necessary for carrying out the projects are presented at appropriate times. They provide the opportunity to develop practical skills and allow for actually applying what has been taught in the theoretical sessions. The projects encompass the entire scope of data acquisition, modelling, analysis, and reporting in a geo-information context, and are complemented by supporting lectures on programme-wide earth science and geo-information topics, as well as stream-specific topics. Participants will work in small teams for the projects, Up to this point the program is the same for students that pursue the Postgraduate diploma and the Master of Science degree. The third block is where the programs start to differ.

Postgraduate diploma – Final project

The **Postgraduate diploma course** continues with an individual **final project** that requires participants to bring together all theoretical and practical skills gained in the course up to that moment and carry out a real-world, practical assignment. The individual final project forms the last part of the course before graduation from the Postgraduate degree course. Focus is on the application of advanced survey techniques and data acquisition methods for the generation of stream relevant earth scientific information and understanding. The project also provides an opportunity for the development of 'life skills' (e.g. teamwork, project planning, problem-solving, presentation and communication).

Research Modules and Advanced Modules

The participants in the **Master of Science degree course** will start with their **research preparation** and ultimately will carry out their **thesis research**. The preparation for the research is done in block three, and the actual thesis research is carried out in block four. For the MSc course, block three consists of 5 modules, of which the first one introduces participants to research skills, helps to develop a critical research attitude and provides pointers for developing the research proposal. This is followed by 2 modules (module 12 and 13) of advanced topics. The advanced topics are offered by the scientific departments in ITC and can be selected freely (under the condition that subjects are relevant for the selected research theme in which the thesis research will be done).

The advanced modules have a multi-disciplinary character, aiming at research skills and advanced research methods/ tools which are useful for students from different courses. A list of modules that will be offered in the 2009-2011 course will be announced separately in the end of 2009.

All MSc research is done in the framework of one of the ongoing research projects in the Institute and all participants will select a research topic that fits within one of those themes. The themes present themselves during the MSc Fair. During the last two modules in this block (module 14 and 15) the participants will start orienting themselves towards the selected research theme. The program is organized and managed by the scientific leaders of the various research themes in ITC. Participants will work together with research staff on subjects and issues that are relevant in the framework of the research theme that has been selected. The research proposal will be written in this period.

Block three ends with the presentation and defence of the research proposal. Upon successful completion of this block the participants will start the actual thesis research.

Note: A positive evaluation of the MSc. research proposal by the Thesis Admission Committee at the end of Module 15 is conditional before admittance to the remainder of the research period,

MSc Research

Block 4 of the MSc course is dedicated to the actual thesis research. A period of 8 modules is reserved for this in which the research has to be carried out and also the thesis has to be written and submitted. The MSc course ends with the defence of the thesis after which the MSc students will graduate.

A schematic overview of the PGS and MSc courses is shown in the table that is presented on the following page.

Schematic overviews of the Postgraduate diploma and the Master of Science degree courses

Module	Dates	Applied Earth Sciences 2008-2009-2010 MSc, PGD and short course schedule	
	14 September 24 September	(PGD and MSc) Arrival, remedial teaching Opening Academic Year	
1	28 September	BLOCK 1, Intro and Core modules (PG and MSc): "Principles and Applications of Remote Sensing and GIS for Applied Earth Sciences."	
2	19 October		
3	9 November		
4	30 November		
22 December 2008 – 3 January 2009		Christmas & end-of-year break	
5	4 January	BLOCK 2, Domain Modules " Geo-information & Earth Observation for Problem Solving in Applied Earth Sciences " "Advanced Earth Observation and quantified modeling in Applied Earth Sciences"	
6	25 January		
7	15 February		
8	8 March		
9	29 March		
10	19 April		
11	17 May	Postgraduate (PGD) Final Project (start 10 May).	BLOCK 3 (MSc) Module 11-15 MSc Research Skills
12	7 June		Advanced Subject 1
18 June (2009)		PGD graduation	
13	28 June	Advanced Subject 2	
14	19 July	Introduction to Research Themes	
15	9 August	MSc. Proposal preparation and presentation	
16-23	6 September	Individual Research Phase (MSc) Preparation, fieldwork (optional), data analysis, mid-term presentation, thesis writing and presentation, and MSc examination	
11 March (2010)		MSc graduation	

Module No.	Title	Coordinator
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AES Block 1: Core modules

1-4	Principles and Applications of Remote Sensing and GIS for Applied Earth Sciences	C. Hecker
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AES Block 2: Domain modules

	This block consists of common and stream specific topics	
	Common topic (generic, compulsory)	
5-10	Image Interpretation and Geo-databases	Dr. T. Woldai
	Life Skills	Dr. D.G. Rossiter
	Active Methods in Remote Sensing	Dr. M. van der Meijde
	Geostatistics	Dr. D.G. Rossiter
	Stream specific topics - ERE	
	Airborne Geophysics	Dr. F.J.A. van Ruitenbeek
	Geology and Mineral Deposits	Dr. E.J.M. Carranza
	Mineral Prospectivity Mapping	Dr. E.J.M. Carranza
	Project 1: Regional Mineral Exploration	Dr. F.J.A. van Ruitenbeek
	Multi- and Hyperspectral Remote Sensing	Dr. F.J.A. van Ruitenbeek
	Exploration and Environmental Geochemistry	Drs. J.B. de Smeth
	Project 2: Follow-up Exploration Techniques	Dr. F.J.A. van Ruitenbeek
	Stream specific topics - GEE	
	Site Investigations and Engineering Mapping	Dr. H.R.G.K. Hack
	Soil Mechanics	Dr. H.R.G.K. Hack
	Rock Mechanics	Dr. H.R.G.K. Hack
	Laboratory Testing	Dr. H.R.G.K. Hack
	Environmental Geochemistry	Dr. J.B. de Smeth
	3D GIS and Modelling	Dr. H.R.G.K. Hack
	Project 1: Engineering feasibility study.....	Dr. H.R.G.K. Hack
	Environmental Impact Assessment	Dr. M. van der Meijde
	Engineering Spectroscopy	Dr. M. van der Meijde
	Project 2: Assessment of Hydrocarbon Pollution	Dr. M. van der Meijde
	Geo-Environmental Engineering and Geo-Hazards	Dr. M. van der Meijde
	Stream specific topics - GH	
	Geo-hazards and Image Interpretation	Drs. R. Voskuil
	Data Collection for Geo-Hazards Assessment	Ir. B.G.C.M. Krol
	Hazard Analysis 1: Empirical Modelling	Dr. D. Shrestha
	Project 1: Hazard Assessment	Drs. N. Kingma
	Hazard Analysis 2: Process based Modelling....	Prof. Dr. V. Jetten
	Risk Assessment	Dr. C.J. van Westen
	Project 2: Risk Assessment	Dr. C.J. van Westen

AES Block 3: Postgraduate diploma – Final Project

11	Final Project PGD	Drs. J.B. de Smeth
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AES Block 3: MSc Degree – Research Profile

11	Research Skills	Dr. D. Rossiter
12-13	Advanced Topics	Dr. M.J.C. Weir
14-15	Research Themes / MSc qualifier	Dr. M.J.C. Weir

AES Block 4: MSc Research

16-23	MSc Research and Thesis Writing	MSc Supervisors
	MSc Fieldwork (optional)	
	MSc Research	
	Mid-term Presentation	
	MSc Thesis Submission	Thesis Assessment Boards
	MSc Defence	

2.4 Staff**Academic Board**

The ITC Academic Board, of which all full-time and part-time professors are members, is responsible for policy development and quality assurance of both education and research.

In general terms the Academic Board is responsible for the following items:

- Quality assurance of the MSc and Master Degree programs and Diploma courses of ITC, irrespective of location.
- Policy of ITC's current degree programmes, both in Enschede and abroad, and in partnership with third parties.
- Programme wide issues, like assessment regulations and core curriculum
- Orientation, content, quality and development of the ITC research program
- Quality assurance of the PhD programme.

Portfolio Holder

Members of the Academic Board will be appointed as *portfolio holders* for individual courses. These portfolio holders will:

- Be first point of contact for Course Directors with respect to course content and quality assurance.
- Monitor the course specific implementation of decisions of the Academic Board.

Course Director (CD)

The Course Director is responsible for implementation and day-to-day management of the courses in a domain. These tasks include approval of structure and contents of the modules of the AES course. Furthermore, Course Directors deal with matters arising prior and during the course, such as pre-selection of candidates, administration and logistics of the course, and fieldwork. Course Directors also implement quality assurance measures, and approve fieldwork topics for the PGD and thesis topics for the MSc courses.

The Course Director will be assisted in all matters related to implementation of the course by block coordinators and the student advisors.

The Course Director reports to the Educational Portfolio Holder of the Academic Board.

The Course Director is authorized by and accountable to the Head Education.

Course Secretary (CS)

The Course Secretary gives administrative support to the Course Director, block and module coordinators and course lecturers for the execution of the courses.

Coordinator


A coordinator is responsible for implementation and day-to-day management of a course or part of a course. The coordinator coordinates the different education activities and the work of the involved staff members. In most cases this task is done under the authority of the Course Director. Within the AES block coordinators are assigned for block 1 and block 2. Module coordinators are assigned to most individual modules in the course.







Student Advisor




Lecturer who advises the individual student on study related issues during a substantial part of the course. The advisory task is not specifically related to a module or group of modules, but aims to support the students in all matters related to the course program. The student advisor is the first point of contact for the student. He/she can help with identifying and patching up of gaps in basic knowledge of students, and can provide clarification and support in making choices (i.e. for advanced subjects, research topics, etc).

Supervisor


The supervisor (e.g. thesis supervisor, IFA supervisor) helps students who work mainly independently. The supervisor may help with the process and with the content and therefore will always be an expert in the topic that the student works on.

Course Director	
<p>Tom Loran</p> <p>Room 4-107 Phone 545</p>	

Module Coordinators and Student Advisors			
<p>Chris Hecker <i>MC 1-4: Block 1 Core modules</i></p> <p>Room 5-042 Phone 356</p>		<p>Mark van der Meijde <i>Student Advisor GEE stream</i></p> <p>Room 4-029 Phone 322</p>	
<p>Mark van der Meijde <i>MC 5-10 Block 2 Domain modules</i></p> <p>Room 4-029 Phone 322</p>		<p>Boudewijn de Smeth <i>MC 11-12 PGD Project Student Advisor ERE stream</i></p> <p>Room 4-035 Phone 310</p>	
<p>Freek van der Meer <i>MC 11</i></p> <p>Room 5-007 Phone 353</p>		<p>Dhruba Shrestha <i>Student Advisor GH stream</i></p> <p>Room 4-048 Phone 264</p>	

<p>David Rossiter MC Advanced Subjects Module 12-13</p> <p>Room 4-058 Phone 499</p>		<p>Robert Voskuil Student Advisor GH stream</p> <p>Room 5-044 Phone 290</p>	
<p>Victor Jetten AES Portfolio holder for AB MC 14-15</p> <p>Room 5-035 Phone 412</p>			

Supporting staff Applied Earth Sciences

<p>Anneke Nikijuluw-Van der Horst Course Secretary</p> <p>Room 4-015 Phone 568</p>			
<p>Job Duim (Technical Support)</p> <p>Room 4-126 Phone 246</p>		<p>Benno Masselink (Technical Support)</p> <p>Room 4-126 Phone 246</p>	

Lecture Timing

Lectures and practicals are given in four periods every working day:

1 st period	08.40 till 10.20
Coffee break	
2 nd period	10.40 till 12.20
Lunch break	
3 rd period	13.40 till 15.20
Tea break	
4th period	15.40 till 17.20

Module descriptions

3. Module descriptions

Principles and Applications of Remote Sensing and GIS for Applied Earth Sciences		
Module: 1-4	Module coordinator:	
Start: 28-09-2009	C.A. Hecker, MSc	
End: 18-12-2009		
Level: MSc, PGD	ECTS: 20	U09-AES-154

Introduction

These modules introduce the modern practices, processing techniques and applications of remote sensing (RS) and geographic information systems (GIS) to solve earth science related challenges. Participants learn how to independently design and carry out sequential data processing chains in the field of Earth Sciences.

Furthermore, these modules will offer participants an overview on state of the art in earth observation (EO) systems and geoinformation (GI) science for earth scientists. Focus is on the relation between earth processes and products and remote sensing systems and the embedding in geodata infrastructures. Aspects related to policy and decision making and relevant international frameworks in which EO/GI is embedded are discussed. Participants are also introduced to project-based learning and the tutor coaching system.

The knowledge on concepts and techniques introduced in these modules will be further developed during subsequent modules of the course.

Objectives

Main objective: To learn how to generate information about the Earth from remote sensing and data stored in Geographic Information Systems for applications in the Earth Sciences.

At the end of the course participants must be able to:

Explain the principles and use the vocabulary of RS and 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;
- Explain the role of RS in GIS in their field of application;
- Describe the physical background of remote sensing and compare the main platforms and sensor systems using examples for Applied Earth Sciences;
- Explain the main digital image processing procedures in Applied Earth Sciences;
- Describe the common methods of image analysis in Applied Earth Sciences;
- Outline the principal rules for cartographic visualisation;
- Describe aspects of data quality and how various stages of spatial data handling affect it.
- Outline state-of-the-art RS/GIS technology and techniques in Applied Earth Sciences

Carry out basic RS/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;
- Perform basic image processing techniques in Applied Earth Sciences;
- Carry out a visual interpretation of an AP stereo pair and a satellite image in Applied Earth Sciences;
- Apply basic data quality assessment procedures;
- Communicate RS/GIS products to audiences with variable levels of expertise;
- Evaluate the influence of different scales and types of imagery on the resulting products

Apply appropriate RS/GIS methods for problem solving

- Understand the capabilities, uses and limitations of GIS and RS in Applied Earth Sciences;
- Design and carry out sequential data processing steps for solving a typical earth science application problem;
- Evaluate the results of data processing;
- Be aware of organisational issues of GIS development and implementation;
- Identify and evaluate data archives relevant to their field of application;
- Resolve new tasks independently though consultation of library and online resources
- Analyse GI/EO problems for Applied Earth Sciences in a systematic way, formulate questions and propose solutions, designing flow charts.

At the end of the course participants are further expected to:

- Understand the AES course structure, get to know their study advisor and their preferred trajectory.
- Be aware of the tutor system and the functions of project tutors.
- Recognize their own responsibilities for the success of their learning process.

Contents

The modules cover the following topics:

- Introduction to the AES course
- Introduction of participants' backgrounds in Participants Workshop
- Introduction to earth science research activities at ITC
- Demonstrations of EO/GI laboratories and equipment at ITC
- Overview of modern concepts in earth sciences, systems approaches and dynamic modeling
- Overview of EO systems and GI structures relevant to modeling earth science processes.
- Excursion to EO/GIS-Institutions and Earth Systems in the Netherlands
- Geographic information and spatial data types.
- Determining and mapping position.
- Spatial data entry and preparation.
- Spatial data analysis.
- The electromagnetic spectrum.
- Sensors and platforms.
- Thermal, hyperspectral and geophysical remote sensing methods.
- Geometric aspects of remotely sensed data.
- Image enhancement and visualisation.
- Image classification and interpretation.
- Spatial data visualization.
- Univariate statistics for EO/GI
- Quality assessment of spatial data.
- Literature research

The modules include practical exercises, practical assignments and an excursion.

Prerequisites

Admission to AES course or short course.

Recommended Knowledge

Basic computer skills, stereo vision, basic Earth Science knowledge.

Compulsory textbook(s)

Mandatory:

- O. Huisman and R.A. de By (ed.), 2009: Principles of Geographic Information Systems - An introductory textbook, 4th ed., ITC, ISBN 90-6164-269-5
- K. Tempfli, N. Kerle, L.L.F. Janssen and G.C. Huurneman (eds.), 2009: Principles of Remote Sensing - An introductory textbook, 4th ed., ITC, ISBN 90-6164-270-1
- G.F. Bonham-Carter, 1994: Geographic Information Systems for Geoscientists: Modeling with GIS, Pergamon, 398 p. ISBN: 0-08-042420-1
- Sabins 2007.

Optional:

- T.M. Lillesand, R.W. Kiefer, J.W. Chipman, 2003: Remote Sensing and image interpretation, 5th ed., Wiley, 784 p. ISBN: 0471152277.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
25	27	0	0	29	48	19

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 (theory)
- Written closed book exam on the ITC RS textbook (theory)
- Graded group assignment on AES specific topics in GIS and remote sensing
- Graded Individual Practical Assignment

Note:

- Module 1 will be assessed based on participation and will receive the notification completed or fail
- The modules 2, 3 and 4 will each receive an assessment on the basis of the assignments and examinations listed above.
- Module 2 will receive the grade obtained for the exam on the ITC RS textbook
- Module 3 will receive the grade obtained for the exam on the ITC GIS textbook
- Module 4 will receive a grade that is based on the graded assignments done during the modules

Common topic: Image Interpretation and Geodatabases			
Module: 5		Module coördinator(s): Dr. T. Woldai	
Start:	04-01-2010		
End:	22-01-2010		
Level: MSc, PGD		ECTS: 2	U10-AES-109

Introduction

The interpretation of aerial photographs and satellite images is a cost effective and efficient way of extracting information on the earth's surface and subsurface for use in many aspects of earth resources and geo-environmental management. Such information is normally stored in geodatabases in which earth science data from various sources can be stored, searched, and retrieved rapidly and accurately according to user requests.

This module introduces the basic concepts and techniques for extracting spatial information from remotely sensed data and introduces techniques to organize and store spatial information (and related attributes) in spatial databases.

Objectives

The subject of image interpretation and geo-databases aims to introduce participants to the principles and practice of interpreting remotely sensed data. This is done in the context of applied earth science applications and puts the interpretation in a context of geology, geomorphology and terrain, and soils. The subject will help participants to recognize relevant spatial information and will help to relate this to the structure of and processes at the earth surface.

The subject aims to introduce participants to the principles and practice of organizing extracted information in existing spatial databases (i.e. making use of data structures, documentation procedures, etc).

Contents

- Selection and preparation of imagery for interpretations purposes
- Use of various types of remotely sensed data at different scales
- Image characteristics and their relation to spatial information and processes in applied earth science
- Interpretation of imagery and extraction of spatial data and information within an applied earth science context (ie. Geology, geomorphology)
- Organization and storage of data in structured data catalogues and spatial databases

Prerequisites

- Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent)
- Background in Earth Sciences
- Good stereoscopic vision

Recommended Knowledge

Non-earth scientists attending the course are recommended to read up on basic geology and geomorphology.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
8	18	0	0	0	14	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

Assessment is based on the results of the practical exercises and assignments.

Common topic: Life Skills		
Module: 6-7	Module coordinator(s): Dr. D.G. Rossiter	
Start:	25-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 1	U10-AES-108

Introduction

All scientific workers are responsible for communication in two directions: from others (as represented by the scientific literature) to themselves, and from themselves to other scientists, research sponsors, and the general public. This set of three lectures/exercises is intended to raise awareness of the importance of scientific communication skills, and to give the students a chance to practise them.

Objectives

At the end of this topic, the student should be able to:

- Find scientific literature relevant to a given topic, using resources of the ITC library
- Summarize the key points of a research paper: what were the objectives, methods, and key findings?
- Present the key points of a research work to the general public or research sponsors
- Prepare a written summary of a research work for the general public or research sponsors.

Contents

- Extracting information from scientific literature: finding relevant literature and summarizing its key points
- Presenting the results of (research) work to scientific peers and the general public
- Reporting the results of (research) work to scientific peers and the general public

Prerequisites

None.

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

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

Through grading of assignments.

Common topic: Active Methods in Remote Sensing		
Module: 6-7	Module coordinator(s): Dr. M.van der Meijde	
Start: 25-01-2010		
End: 05-03-2010		
Level: MSc, PGD	ECTS: 2	U10-AES-111

Introduction

Active remote sensing technologies have the potential to provide accurate information about the land surface and subsurface by imaging (geo)physical properties in 2D and 3D. A combination of surface and subsurface information is essential while studying natural hazards, geo-engineering problems or finding natural resources.

Shallow geophysical non-destructive methods can give insight in physical parameters of the sub-surface that will go undetected with other methods. Information can be obtained about on layering, stability of various layers, seismic velocities, conductivity/resistivity, etc. The use of geophysical techniques gives a possibility for obtaining detailed information in a non-destructive and environmentally friendly way.

Radar and lidar provide very detailed information on surface topography and earth motions visible at the surface with a very high accuracy. They are often used in geo-engineering, environmental and hazard studies.

Objectives

At the end of this topic, the student should be able to:

- Understand the basic theory of the aforementioned active methods in remote sensing
- Determine the applicability of the various methods for their field of interest
- Recognize the importance of integrating geophysical data with other data sources
- Understand the basics of geophysical interpretations

Contents

This introductory lecture series will deal with the basic theory of most widely applied geophysical techniques in various fields of earth sciences, radar (insar) and lidar. In case studies we will discuss the potential and applicability of the various methods for different application fields such as natural hazards, geo-engineering and natural resource exploration. Data management and integration of data with respect to other data sources is also an important aspect of the lecture series.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

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

Written (2nd week of module 7), and oral (end of module 7).

Common topic: Geostatistics		
Module: 8-9	Module coordinator: Dr. D.G. Rossiter	
Start:	08-03-2010	
End:	16-04-2010	
Level: MSc, PGD	ECTS: 2	U10-AES-110

Introduction

Almost all data in earth science studies is spatially-explicit, that is, from known locations on, in, or over the earth's surface. These data must be assumed to have a spatial structure; that is, the data values can not be considered independent of their relative location. This provides opportunities to use the data to examine this structure and to map by trend surfaces or local interpolation (e.g. kriging), but also requires specialised methods to avoid incorrect inferences. It also opens the possibility to understand earth science processes by statistical inference.

Statistics is an important component of models – mathematical models – where the real world is described in terms of equations, functions or statistics. Different approaches to mathematical modelling will be explained and demonstrated in short exercises with emphasis on the reach and limits of the applicability of each approach.

Objectives

At the end of this topic, the student should be able to:

- explain the difference between geographic vs. feature spaces, and when analysis in each is appropriate to earth science problems;
- compute regional trends by regression analysis and map using trend surfaces;
- compute local structure by variogram analysis and map using ordinary kriging;
- prepare a probability-of-exceedence map by indicator kriging
- determine anisotropy in local structures

Contents

- Geographic vs. feature spaces
- Theory of spatial dependence (spatially-correlated processes)
- Concepts of spatial sampling: support, independence
- Modelling regional trends by regression on coordinates
- Discovering and modelling spatial dependence; the experimental and fitted variogram and correlogram
- Mapping by trends and local interpolation (kriging)
- Non-parametric methods for thresholds and extreme values
- Directional statistics: anisotropy
- Introduction to modelling / modelling approaches

Prerequisites

- Core Module – basics of GIS including statistics of image analysis
- Background in Earth Sciences
- First university-level courses in mathematics (introductory linear algebra, vectors and matrices) and (non-spatial) descriptive and inferential statistics (probability, distributions, correlation, regression)

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
8	14	0	0	0	10	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

Written (2nd week of module 9), and oral (end of module 9).

ERE topic: Airborne Geophysics		
Module: 5-6	Module coordinator: Dr. F.J.A. van Ruitenbeek	
Start: 04-01-2010		
End: 12-02-2010		
Level: MSc, PGD	ECTS: 3	U10-AES-131

Introduction

Identifying earth resources for development is a complex undertaking in our challenged environment and one that relies on conceptual models and the application of modern technologies. Economic conditions, environmental consequences and societal constraints further influence decision making about their actual development. Non-destructive geophysical investigative methods play a crucial role in modern exploration for natural resources. The application of airborne and ground based geophysical methods is of importance in practically every phase of the exploration process: From the large scale airborne regional reconnaissance to ground based follow-up studies. The focus of the lectures will be on potential field methods and radiometrics. All lectures will be linked and integrated into the two major projects and several smaller case studies.

Objectives

At the end of this lecture series, the student should be able to:

- understand the mathematical and physical background of the various potential field methods and radiometrics,
- know the applicability of the various methods for detection and monitoring of various targets,
- apply the various geophysical methods in a useful way,
- analyse and interpret the results of the geophysical methods in a multi-disciplinary approach.

Contents

This lecture series will focus on potential field methods (magnetics and gravity) and radiometrics (gamma-ray spectrometry). Topics that will be discussed include:

- Introduction to basic physical principals.
- Summary of data acquisition and processing.
- Qualitative analysis
- Estimating geological parameters from data analysis using data-driven or knowledge driven approaches.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

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

Written (2nd week of module 7), and oral (end of module 7).

ERE topic: Geology of Mineral Deposits		
Module: 5-7	Module coordinator: Dr. E.J.M. Carranza	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 3	U10-AES-130

Introduction

Identifying and finding mineral resources for development is a complex undertaking in our challenged environment and one that relies heavily on conceptual deposit and exploration models and the application of modern technologies. In the case of deposit and exploration models, economic geology and structural geology are very closely related. In general, mineral deposit occurrences are structurally- and geochemically-controlled. Therefore, an area's potential for certain types of mineral deposits can be described in terms of geological setting, structural control and geochemical (alteration) environment.

Objectives

At the end of this topic, the student should:

- Have gained knowledge of geologic controls on occurrence of certain types of mineral deposits and signatures of mineralized ground in geological, geophysical and geochemical datasets;
- Be able to identify appropriate key criteria that can be used in predictive GIS modelling of prospectivity for certain types of mineral deposits (e.g. structural features, geophysical responses, geochemical assemblages, stratigraphic/sedimentary features).
- Be able to assess the prospectivity of a given area with regards to the main classes of ore deposits (e.g. magmatic, hydrothermal, sedimentary);

Contents

The lecture series covers the mode of formation, structural control and geochemical signatures of mineral deposits. The occurrences of certain types of mineral deposits will be discussed in terms of geological setting, structural control and geochemical environment.

The emphasis of the lectures will be on recognition of geological, geophysical and/or geochemical signatures that can be used for prospecting and assessing the potential of an area for a certain type of mineral commodity.

The lectures will be integrated into the two major projects and several smaller case studies.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable.

Comulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
28	14	0	0	0	14	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

Written (2nd week of module 7), and oral (end of module 7).

ERE topic: Mineral Prospectivity Mapping		
Module: 5-7	Module coordinator: Dr. E.J.M. Carranza	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 1	U10-AES-132

Introduction

Despite our considerable knowledge about the Earth, it remains difficult to predict where to find mineral deposits. The basic problem is that ore-forming processes evolve at widely different spatial and temporal scales. Mineral exploration and mineral prospectivity mapping are (therefore) multi-disciplinary fields: they involve geology, geophysics and geochemistry. This module (MINPROS) is concerned with analysis and integration of various types and sets of relevant spatial (geological, geophysical, geochemical) evidence of occurrence of mineral deposits of the type sought. The evidential data sets are input to GIS-based predictive mapping of prospective land for mineral deposits of the type sought.

Objectives

On completion of this module, students should have acquired basic understanding and skills of applying GIS-based methods for:

- Knowledge-driven modeling of mineral prospectivity
- Data-driven modeling of mineral prospectivity
- Cross-validation of mineral prospectivity models

Contents

The lecture and practical exercise series covers GIS-based map representations of prospectivity recognition criteria based on conceptual mineral deposit models, methods for knowledge-driven assignment and data-driven calculation of weights of spatial evidence of mineral prospectivity and method for evaluating performance of a mineral prospectivity map.

Prerequisites

- Background in mineral deposit geology
- Basic knowledge of mathematics and statistics

Recommended Knowledge

GIS operations

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
4	8	0	0	0	4	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

Written (2nd week of module 7), and oral (end of module 7).

ERE project 1: Regional Mineral Exploration		
Module: 6-7	Module coordinator(s): Dr. F.J.A. van Ruitenbeek	
Start:	25-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 5	M10-AES-133

Introduction

In regional exploration studies various techniques are used to obtain geological information that is relevant to finding mineralization of interest. The type of deposit and the scale of investigation determine suitability of the various methods. On regional reconnaissance scale methods are used that can quickly provide geological information of large areas. Airborne geophysical data, such as magnetics and gamma-ray spectrometry, and spectral remote sensing, such as Landsat TM and ASTER, are very suitable to obtain geological information over large areas. Integrated analyses of these data sets provide a geological framework that is necessary for investigation of mineral potential. Exploration criteria or exploration guides that are obtained from conceptual deposit models of the mineral of interest are used to further analyse remote sensing and other geological data sets for finding mineralization itself. Proper management of data sets and their derived products, such as interpretations or classifications, is an essential part of the regional exploration study.

Objectives

At the end of this topic, the student should be able to:

- understand the principles and techniques in regional exploration studies;
- determine the suitability of various methods for exploring a target of interest;
- make a geological interpretation on various scales with multi-source remote sensing data;
- determine exploration criteria from conceptual deposit models;
- extract the necessary geological information from geological, geophysical, and remote sensing data sets for determining mineral potential.

Contents

In this project two regional exploration case studies are presented. The first case study is about geologic mapping and exploration in an Archean granite greenstone terrain in Western Australia, the Pilbara. The area hosts numerous mineral occurrences of various commodities. It is relatively undeformed and well exposed. Therefore is it very suitable for exercising remote sensing based method in mineral exploration. The second case study is on geologic mapping and mineral exploration in the Tete Province of Mozambique. This area is geologically more complex and is host to many different types of deposits. The project consists of two parts. First a regional geologic interpretation with remote sensing data will be made. After that conceptual models of various commodities will be used together with mineral occurrences data and multi-source data sets to determine mineral prospectivity of the area. Results will be presented by oral presentation and a report.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics
- Core module ITC

Recommended Knowledge

Knowledge of GIS and remote sensing, geology

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
4	0	0	84	0	0	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

Final report and presentation in the last week module 7.

ERE topic: Multi- and Hyperspectral Remote Sensing			
Module: 7		Module coordinator: Dr. F.J.A. van Ruitenbeek	
Start:	15-02-2010		
End:	05-03-2010		
Level: MSc, PGD		ECTS: 2	U10-AES-134

Introduction

Remote sensing, also called earth observation, refers in a general sense to the instrumentation, techniques and methods used to observe, or sense, the surface of the earth, usually by the formation of an image in a position, stationary or mobile, at a certain distance remote from that surface. In spectral remote sensing energy reflected from an object, is being measured and translated into information about the object or into processes related to the object. Reflectance spectra have been used for many years to obtain compositional information of the Earth surface. Spectral reflectance in visible and near-infrared offers a rapid and inexpensive technique for determining the mineralogy of samples and obtaining information on chemical composition. Recent developments in this field are fast and this lecture series will introduce state-of-the-art techniques in multi- and hyperspectral processing and interpretation. All lectures will be highly linked and integrated into the two major projects and several smaller case studies.

Objectives

At the end of this topic, the student should be able to:

- understand the principles of multi- and hyperspectral remote sensing;
- determine the applicability of the various detection and analysis techniques for their field of interest;
- apply the various processing and analysis techniques in a useful way;
- interpret the results of the various processing and analysis techniques in a multi-disciplinary approach.

Contents

The lecture series will provide a comprehensive overview of spectral remote sensing in Earth Science. Topics that will be discussed include:

- reflectance properties of earth materials;
- acquisition and pre-processing of remote sensing imagery;
- image enhancement and analysis techniques such as ratioing, classification, spectrum matching, sub-pixel classifiers and spectral processing including the spatial domain;
- estimating physical and chemical parameters from spectral data sets.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	18	0	0	0	12	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

Written (2nd week of module 7), and oral (end of module 7).

ERE topic: Exploration and Environmental Geochemistry		
Module: 8-9	Module coordinator: Drs. J.B. de Smeth	
Start:	08-03-2010	
End:	16-04-2010	
Level: MSc, PGD	ECTS: 3	U10-AES-135

Introduction

The use of geochemistry in the field of mineral exploration and environmental studies is widely spread. Environmental and exploration geochemistry uses the chemical concentration of major, minor and trace elements in the earth materials in order to delineate distribution patterns in relation mainly to geological, ore forming- and environmental processes. In both these fields similar sampling and analytical concepts and techniques are used to make spatial element distribution patterns visible. These patterns or combined patterns are related to element concentrations which in combination with mineralogy, geology, hydro-geology and geomorphology can provide insight on the location and extent of hidden ore deposits, sources of pollution or the extent to which the environment has been disturbed and/or is at risk.

All lectures will be highly linked and integrated into a major project and several smaller case studies/exercises.

Objectives

At the end of this topic, the student should be able to:

- understand the principles of natural and anomalous element abundance and dispersion;
- apply the various geochemical sampling techniques for different environments;
- choose appropriate analytical methods on geochemical samples and data sets;
- interpret the results of the various sampling and analysis techniques in a multi-disciplinary approach.

Contents

The lecture series will cover the principal geochemical methods. Topics that will be discussed are among others:

- Elements, minerals, their natural abundance and chemical behaviour and dispersion processes in the near surface environment in rocks, soils, sediment and water, anomalous element concentrations;
- Geochemistry of rocks and soils, hydro and drainage geochemistry as well as sampling methods, quality control measures and demonstration of sample analysis in ITC's geochemical laboratory using UV-Vis, AAS and ICP-AES instrumentation;
- Choices in sampling and analytical laboratory procedures;
- Data interpretation- and modelling techniques to assess for example the mineral potential of a surveyed area;
- Newest developments in geochemistry.

Prerequisites

Background in Earth Sciences.

Recommended Knowledge

Basic knowledge of inorganic chemistry and univariate statistics.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
14	28	0	0	0	14	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

Written (2nd week of module 9), and oral (end of module 9).

ERE project 2: Follow-up Exploration Techniques			
Module: 9-10		Module coordinator: Dr. F.J.A. van Ruitenbeek	
Start:	29-03-2010		
End:	07-05-2010		
Level: MSc, PGD		ECTS: 5	U10-AES-136

Introduction

In follow-up exploration studies various techniques are used to obtain geological information that is relevant to finding mineralization of interest. Suitability of the various techniques depends on the type of deposit and the scale of investigation. In local-scale exploration campaigns, methods are used that can provide detailed geological information on relatively small areas and methods that can directly or indirectly detect mineralized zones. Hyperspectral remote sensing, geochemical methods, and ground based geophysics, such as gamma-ray spectrometry and potential field methods, are suitable to obtain geological information in high spatial resolution and for delineation of potentially mineralized zones. Integrated analyses of these data sets provide the information that is necessary for investigation of mineral potential. Exploration criteria that are obtained from conceptual deposit models are used to further analyse remote sensing and other geological data sets for finding mineralization itself. Proper management of data sets and their derived products, such as interpretations or classifications, is an essential part of the local exploration study.

Objectives

At the end of this topic, the student should be able to:

- understand the principles and techniques in follow-up exploration studies;
- determine the suitability of various methods for exploring a target of interest in the follow-up stage;
- make an interpretation of the area on various scales in terms of geology and mineralized zones with multi-source remote sensing and ground data;
- determine exploration criteria from conceptual deposit models.
- extract the necessary geological information from geological, geophysical, geochemical and remote sensing data sets for finding mineralization.

Contents

In this project a follow-up exploration case study is presented. Area of interest is the Cabo de Gata volcanic province in south-eastern Spain where various types of epithermal mineralization are related to extensive hydrothermal alteration events. The area hosts high sulfidation and low sulfidation precious metal and base metal deposits that contain Au, Ag, Pb, Zn and Cu. Several industrial mineral deposits such as bentonite, alunite and gypsum occur in the area. Lithology is well exposed since vegetation is sparse and weathering is limited and therefore the area is very suitable for studying geology and rock alteration patterns.

The project consists of several parts. First a regional geologic interpretation will be carried out using remote sensing data upon which map areas with high exploration potential will be selected for further investigation with hyperspectral, geophysical and geochemical techniques. This includes validation of remote sensing based interpretation with ground data using field spectrometers.

Finally, potentially mineralized zones, which are of interest for further investigation, such as soil sampling or reconnaissance drilling, will be delineated by integration of the various available data layers. Results will be presented by oral presentation and a report.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics
- Core modules ITC
- ERE project 1 - Pilbara

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
4	0	0	88	0	0	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

Final report and presentation in the last week module 10, possible mid-term presentation.

GEE topic: Site Investigations and Engineering Mapping		
Module: 5	Module coordinator: Dr. H.R.G.K. Hack	
Start:	04-01-2010	
End:	22-01-2010	
Level: MSc, PGD	ECTS: 1	U10-AES-119

Introduction

Site investigation is a complex process. It involves the acquisition of geological, geotechnical, and other relevant information which might affect the construction or performance of a civil engineering or building project. Adequate site investigations are vital to the success of any construction project. If no or inadequate site investigations are done, it can lead to very large construction cost overruns. If site investigation is to be effective it must be carried out in a systematic way, using techniques that are relevant, reliable and cost-effective.

Objectives

Upon completion of the topic, the participant should be able to:

- Understand the relevance of site investigations
- Know the standards for describing rock and soil
- Know the various stages of site investigations
- Know the various site investigations techniques and understand in which situations they can and should be used

Contents

- Objectives of site investigations
- Importance of site investigations
- General procedure and stages
- Techniques for acquiring and interpreting data
- Description and classification of soil and rock
- Subsurface exploration techniques
- In-situ testing techniques
- Laboratory and field tests

Prerequisites

Not applicable.

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
2	2	0	0	0	2	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

Written examination.

GEE topic: Soil Mechanics			
Module: 5-7		Module coordinator: Dr. H.R.G.K. Hack	
Start:	04-01-2010		
End:	05-03-2010		
Level: MSc, PGD		ECTS: 2	U10-AES-120

Introduction

During lectures the main topics of the subject will be discussed, and some examples may be shown. Major parts are applied in Stream specific Projects.

Objectives

Upon completion of the topic, the student should be able to:

- Understand of the behaviour of different types of soil, including the determination of the major soil parameters, and the execution of basic calculations.
- Understand the changes of the vertical effective stresses due to surcharges and changes of the ground water levels.
- Have a "feeling" for the order of magnitude of the major soil parameters.
- Determine with approximate methods settlements for the short and the long term, including the consolidation behaviour.
- Understand by which factors the stability of a slope will be influenced in favourable or unfavourable way.
- Make a plan for a site investigation, if required with laboratory tests, and with monitoring during the execution, that will give all the parameter values, that may be important for a certain project in more or less known circumstances.

Contents

Classification of soils; groundwater; phreatic level; heads; coefficient of permeability; vertical flow of ground water; difference between phreatic level and piezometric level; vertical effective stresses in hydrostatic and non-hydrostatic conditions; shear strength; triaxial test; UCS test; ultimate horizontal effective stresses; stress-strain behaviour; settlements according to Terzaghi, oedometer test; pre-consolidation stress; consolidation theory; drainage length; hydrodynamic period for one or more layers; secondary settlement; Anglo-Saxon formula; stability of slopes in soil; slip circle calculations (Bishop); influence of pore water pressures; overview of available in-situ and laboratory testing methods; the planning of a site investigation in more or less known soil conditions for different projects, using the most appropriate field and laboratory tests; monitoring methods to be used during construction.

Prerequisites

Not applicable.

Recommended Knowledge

Stress; strain; logarithms; trigonometric functions.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
11	0	0	0	4	3	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

Written examination. It is allowed to use the booklet with Formulas, tables and graphs.

GEE topic: Rock Mechanics		
Module: 5-7	Module coordinator: Dr. H.R.G.K. Hack	
Start: 04-01-2010		
End: 05-03-2010		
Level: MSc, PGD	ECTS: 2	U10-AES-122

Introduction

The mechanics of discontinuous rock masses are elementary for the safe design of tunnels, dams, foundations and slopes in discontinuous rock masses.

During lectures the main topics of the subject will be discussed, and examples will be shown.

Objectives

Upon completion of the topic, the participant should be able to:

- Understand the mechanical and physical behaviour of discontinuous rock masses
- Understand the interaction between civil engineering structures and discontinuous rock masses
- Understand the specific issues concerning tunnels, dams and foundations in or on discontinuous rock masses

Contents

Intact rock versus rock mass. Characterization and properties of discontinuities in rock. Characterization and properties of discontinuous rock masses. Mechanical and physical behaviour of discontinuous rock masses. Weathering of discontinuous rock masses. Characterization and properties of weathered rock masses. Mechanics of weak rock(s) mass(es) and cemented soils. Principles of flow through discontinuities and discontinuous rock masses. Methods and influence of excavation methods. Influence of blasting and other vibrations. Influence of stress and stress changes. Classification of discontinuous rock masses. Possibilities for analytical and numerical modelling of discontinuous rock masses. Large and small scale testing and monitoring of discontinuities and discontinuous rock masses. Principles of tunnel and dam design. Interaction between discontinuous rock masses and engineering structures, such as tunnels, dams and foundations. Case histories.

Prerequisites

Not applicable.

Recommended Knowledge

Basic knowledge of physics, mechanics, rocks and minerals, and geology.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
11	0	0	0	6	3	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

Written examination.

GEE topic: Laboratory Testing		
Module: 5-7	Module coordinator: Dr. H.R.G.K. Hack	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 1	U10-AES-121

Introduction

Many material and mass properties can be determined in the fields during site investigations or with in-situ testing methods. However, mostly rock and soil samples also have to be tested in a laboratory in order to assess its variability and in order to obtain parameters for particular geotechnical calculations. The rock and soil samples are generally obtained during the site investigations. In order to obtain the proper samples and to acquire the right design properties, it is essential to know and understand the various rock and soil tests that can be carried out.

Objectives

Upon completion of the topic, the participant should be able to:

- Know about different rock and soil laboratory tests
- Understand the different material and mass properties that can be determined
- Know the limitations and complications of the various tests and understand sampling requirements

Contents

- Laboratory tests on rock and aggregates
- Laboratory tests on soil samples

Prerequisites

- Site investigations
- Rock mechanics
- Soil mechanics

Recommended Knowledge

Rock and soil mechanics.

Compulsory textbook(s)

- Rock and aggregate test procedures. Verwaal and Mulder, TU Delft.
- ISRM: "Rock Characterization, Testing and Monitoring", ISRM Suggested Methods, Editor E.T. Brown. Pergamon press 1981
- ASTM: "1985 and 2000 Annual Book of ASTM Standards", Volume 04.08: Soil and Rock; Building Stones. Published by ASTM in 1986.
- BS: 812: Published by British Standards Institution.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
3	0	0	0	6	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

Written examination; assignment.

GEE topic: Environmental Geochemistry		
Module: 5-7	Module coordinator: Dr. J.B. de Smeth	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 3	U10-AES-125

Introduction

During this lecture series the environmental aspects of Geo-Environmental Engineering will be discussed. The lecture series is a mix of what is pollution, the geochemistry of pollution, how to sample different types of pollution and how it can be transported in the subsurface. The lecture series will give a basis for application of engineering principles to reduce and mitigate subsurface pollution.

Objectives

Upon completion of the topic, the student should be able to:

- Understand the problems related to near surface or subsurface pollution, be capable of doing some types of measurements and analysis, understand transport mechanisms for pollution.

Contents

- What is pollution
- Behaviour of chemical components in the near surface environment
- Analytical methods for determining pollution in solids
- Water quality analysis
- Soil leaching of chemical compounds
- Contaminant transport in shallow aquifer
- Assessment procedures for contaminated land

Prerequisites

Basic chemistry and mineralogy.

Recommended Knowledge

Chemistry (especially inorganic), groundwater modeling.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6	0	0	0	3	6	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

Written examination; assignment.

GEE topic: 3D GIS and Modelling		
Module: 5-7	Module coordinator: Dr. H.R.G.K. Hack	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 1	U10-AES-123

Introduction

Numerical modelling and constitutive models of soil and rock masses are often required for the safe design of engineering constructions in or on the soil or rock mass.

During lectures the main topics of the subject will be discussed, and examples will be shown. Practical exercises will be given to give the participants hands-on experience with numerical modeling.

Objectives

Upon completion of the topic, the student should be able to use numerical modelling and to choose constitutive model to model the stability of foundations, slopes and tunnels in or on a soil or rock mass.

Contents

Introduction to numerical modelling for soil and rock:

- Finite element modelling (FEM)
- Distinct element modelling (DEM)

Constitutive models:

- Linear-elastic
- Mohr-Coulomb
- Soft soil
- Soft soil creep
- Hardening soil
- Cam-Clay

Prerequisites

- Rock mechanics
- Soil mechanics

Recommended Knowledge

Soil and rock mechanics.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6	0	0	0	3	6	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

Written examination; assignment.

GEE project 1: Engineering feasibility study for various construction projects in the Baix-Camp area, Spain			
Module: 5-7		Module coordinator: Dr. H.R.G.K. Hack	
Start:	04-01-2010		
End:	05-03-2010		
Level: MSc, PGD		ECTS: 4	U10-AES-126

Introduction

Based on a large-scale multi-purpose engineering geological map, a large-scale (1:5,000) GIS database and an engineering geological mapping report that contains all the relevant engineering parameters, an engineering feasibility study has to be carried out. What are given for the project are the terms of reference to the design of a certain construction that needs to be developed in the project area. The study may involve the preliminary design of tunnels, portals, bridges, embankments and slopes. The aim of this project is to carry out a feasibility study, given the terms of reference and the available data. The delivery of this project is a feasibility report, which should serve as a basis for a tender document and/or a site-investigation project.

Objectives

Upon completion of the topic, the student should be able to:

- Carry out a feasibility study for any engineering work
- Make a preliminary design for e.g. tunnel, bridge, foundation, etc
- Understand engineering geological maps, geotechnical reports
- Write a professional technical report

Contents

The possible topics that you might encounter in this project are:

- Rock mechanics
- Soil mechanics
- 3D modelling
- Numerical modelling
- (GIS) Database design and data handling
- Technical report writing

Prerequisites

- Core Module
- Rock mechanics
- Soil mechanics
- Numerical modelling

Recommended Knowledge

GIS, Rock mechanics, Numerical modelling, Engineering Geological mapping, Data extraction from imagery.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
8	0	0	78	0	0	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

Delivery: Feasibility report, presentation, oral examination.

GEE topic: Environmental Impact Assessment		
Module: 8-10	Module coordinator: Dr. M. van der Meijde	
Start: 08-03-2010		
End: 07-05-2010		
Level: MSc, PGD	ECTS: 2	U10-AES-127

Introduction

During this lecture series various aspects of Environmental Impact Assessment (EIA) will be discussed, especially from a geo-environmental engineering point of view. The lecture series will start with a technical lecture on EIA, the different legislation and how to deal with it. The remaining lectures will be focussed on the implementation of EIA by various organizations. Different organizations involved in EIA will be visited and case studies on how one can deal with pollution problems taking into account the limitations but also possibilities of environmental legislation will be presented and discussed. An important part of the discussion should deal with the implementation of Geo-environmental Engineering techniques for detection, analysis and mitigation of pollution in EIA.

Objectives

Upon completion of the topic, the student should be able to:

- Understand the problems and challenges in EIA, implement EIA in Geo-environmental Engineering practices, have an overview of application of EIA in industry

Contents

- What is EIA
- Different legislation EIA
- Various visits to organizations involved in EIA
- Case studies on EIA problems
- Implementation of Geo-environmental Engineering techniques for detection, analysis and mitigation of pollution in EIA.

Prerequisites

Environmental Geochemistry.

Recommended Knowledge

EIA.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6	0	0	0	3	6	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

T.b.d.

GEE topic: Engineering Spectroscopy		
Module: 8-10	Module coordinator: Dr. M. van der Meijde	
Start:	08-03-2010	
End:	07-05-2010	
Level: MSc, PGD	ECTS: 2	U10-AES-124

Introduction

Remote sensing, also called earth observation, refers in a general sense to the instrumentation, techniques and methods used to observe, or sense, the surface of the earth, usually by the formation of an image in a position, stationary or mobile, at a certain distance remote from that surface. In spectral remote sensing energy reflected from an object, is being measured and translated into information about the object or into processes related to the object. Reflectance spectra have been used for many years to obtain compositional information of the Earth surface. Spectral reflectance in visible and near-infrared offers a rapid and inexpensive technique for determining the chemical composition of samples and from that deriving engineering properties. Recent developments in this field are fast and this lecture series will introduce state-of-the-art techniques in multi- and hyperspectral processing and interpretation.

Objectives

At the end of this topic, the student should be able to:

- understand the principles of multi- and hyperspectral remote sensing;
- determine the applicability of the various detection and analysis techniques for their field of interest;
- apply the various processing and analysis techniques in a useful way;
- interpret the results of the various processing and analysis techniques in a multi-disciplinary geo-environmental approach.

Contents

The lecture series will provide a comprehensive overview of spectral remote sensing in Earth Science. Topics that will be discussed include:

- Reflectance properties of earth materials and vegetation;
- Hyperspectral image enhancement and analysis techniques and spectral processing including the spatial domain;
- Estimating physical and chemical parameters from spectral data sets.

Prerequisites

- Background in Earth Sciences
- Basic knowledge of mathematics and physics

Recommended Knowledge

Multi-spectral remote sensing.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6	0	0	0	3	6	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

Written examination.

GEE project 2: Assessment of Hydrocarbon Pollution		
Module: 8-10	Module coordinator: Dr. M. van der Meijde	
Start:	08-03-2010	
End:	07-05-2010	
Level: MSc, PGD	ECTS: 4	U10-AES-129

Introduction

Leakage of hydrocarbon has a large economic and environmental impact. Traditional methods for investigating leakage and resulting pollution, such as drilling, are destructive, time consuming and expensive. Remote sensing is an alternative that is non-destructive and has been tested extensively for exploration of onshore hydrocarbon reservoirs and detection of hydrocarbons at the Earth's surface. In this project, a leaking pipeline is investigated through field and airborne reflectance spectrometry and the findings are validated with traditional drilling and geophysical measurements.

Objectives

Upon completion of the topic, the student should be able to:

- Interpret surface and subsurface information in the form of maps, cross sections, borehole logs, water samples and translate that into a 2.5D model of pollution distribution in a GIS
- Apply various GE techniques for assessing surface and subsurface pollution
- Write a report relating various datasets into a conclusive recommendation on the extent of pollution and the possible remediation efforts

Contents

- Database handling: using a database of spectroscopic measurements, boreholes, and water samples
- Geochemistry: analysis of all available pollution level and its impact on the environment
- Geostatistics: interpolation of pollution information
- GIS: 2.5 D modelling of the pollution
- Spectroscopy: derive pollution levels from spectral data
- Geophysics: Analyse geophysical measurements for pollution
- Data integration: Integrate the different datasets for pollution analysis and assessment of possible environmental and/or engineering remediation efforts

Prerequisites

Environmental geochemistry, engineering spectroscopy, EIA, active methods in RS.

Recommended Knowledge

GIS, Soil mechanics, geostatistics, database design.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6	0	0	70	0	0	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

Final report, presentation, oral examination.

GEE topic: Geo-environmental Engineering and Geo-hazards			
Module: 8-10		Module coordinator: Dr. M. van der Meijde	
Start:	08-03-2010		
End:	07-05-2010		
Level: MSc, PGD		ECTS: 2	U10-AES-128

Introduction

The study of geo-hazards is a strongly multidisciplinary research field that focuses on the development of innovative and integrated solutions to enhance the resilience of infrastructure against extreme events (earthquakes, landslides, flooding, fires, etc.). Such events often have engineering and/or environmental components related to the direct or indirect effects of the disaster. This lecture series will focus pre-dominantly on earthquakes and landslides.

Earthquakes are one of the most devastating of all natural hazards. In order to do a site-specific hazard assessment or hazard zonation, it is essential to understand the local ground conditions. This forms the basis of earthquake engineering and micro- and macro-zonation.

The stability of existing or new to be made slopes in soil or rock is elementary for the safety of constructions such as roads or buildings, underneath a slope.

During lectures the main topics of the subject will be discussed, and examples will be shown.

Objectives

Upon completion of the topic, the student should be able to:

- Understand the main issues in earthquake engineering and seismic micro- and macro zonation
- Understand how soil and buildings react to earthquake tremors
- assess an existing slope on stability

Contents

Earthquakes:

- Concepts of seismic ground amplification, topographic amplification and liquefaction.
- Liquefaction analysis
- Using surface and subsurface information to create large scale hazard zonation maps, which will form the basis for a risk assessment.
- Different examples of micro- and macro hazard zonation approaches and concepts

Landslides:

- Types of slope instability (e.g. wedge failure, sliding, rotational, rock fall, toppling, buckling) in soil and rock masses
- Analytical slope stability analysis
- Numerical slope stability analysis
- Slope stability classification
- Weathering
- Triggering mechanism (earthquakes, rainfall)

Prerequisites

- Core Modules
- Basic knowledge of soil mechanics and dynamics

Recommended Knowledge

Soil mechanics, dynamics, civil engineering, geotechnical engineering, GIS.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
3	0	0	0	3	3	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

Written examination; assignment.

GH topic: Geo-Hazards and Image Interpretation		
Module: 5-7	Module coordinator: Drs. R. Voskuil	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 2	U10-AES-112

Introduction

This topic will provide an introduction to hazard and risk assessment (definitions, context, types, trends, scales and objectives of hazard assessment, overview of types of hazard assessment, ...). Depending on the type of hazard that is studied, base data is required from different sources and at different scales. Interpretation of aerial photographs and satellite images is an efficient way of collecting this data.

During the image interpretation, emphasis is placed on the extraction of geological and geomorphologic information for geohazard studies. Several techniques of image interpretation will be treated (from traditional stereoscopes to modern on-screen techniques). The aim is to provide basic knowledge regarding geomorphologic processes and the landforms they create and how this knowledge can help in geo-hazard assessment.

Objectives

At the end of this topic, the student should be able to:

- Understand the basic geomorphologic processes and their resultant landforms.
- Recognise specific landforms on images as indicators for geo-hazards.
- Extract relevant information from images using various techniques.
- Understand the requirements of hazard assessment at different scales.

Contents

- Lectures
- Exercises
- Self study

Prerequisites

Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent)
Good stereoscopic vision

Recommended Knowledge

Background in Earth Sciences.

Compulsory textbook(s)

None

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
10	16	0	8	4	10	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 theory will be assessed during the written examination. Practical assignments will be evaluated and graded

GH topic: Data Collection for Geo-Hazard Assessment		
Module: 5-7	Module coordinator: Ir. B.G.C.M. Krol	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 2	U10-AES-113

Introduction

The study of geo-hazards requires timely information from multiple disciplines (such as geology, geomorphology, pedology and geology) and data sources (examples: images, existing maps, digital terrain models). Topography is one of the important factors in hazard and risk analysis. A Digital Elevation Model (DEM) that presents a model of surface elevation can be used to produce a series of terrain parameters. These can serve as input environmental factors in spatial-temporal modelling. Much of the information required for hazard and risk analysis is also obtained from Remote Sensing (RS). For example, RS image data can help us detect existing hazards, but also allow the monitoring of ongoing surface processes.

In this module focus is on two interrelated topics:

1. Construction and use of digital elevation models for terrain parameterization;
2. RS-based change detection for geo-hazard monitoring.

Objectives

At the end of this topic, the student should be able to:

- Carry out Digital Terrain Modelling and construct relevant hydro-morphometric parameter maps;
- Use satellite images for RS-based change detection and monitoring of hazards.

Contents

- Lectures
- Exercises
- Self study

Prerequisites

Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent).

Recommended Knowledge

- Background in Earth Sciences
- Basic understanding of physics, statistics and mathematics.

Compulsory textbook(s)

None

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
14	12	0	8	6	14	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 theory will be assessed during the written examination.

GH topic: Hazard Analysis 1: Empirical Modelling		
Module: 5-7	Module coordinator: Dr. D. Shrestha	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 2	U10-AES-114

Introduction

Hazard assessment is the identification and prediction of potentially hazardous areas. For this we need a tool to help us make these predictions: a model. For hazard assessment there are several approaches, ranging from very simple to very complicated. In this topic we will deal with approaches that are based on observations of the phenomena and how these correlate with spatial factors like geology, slope, etc. Also heuristic approaches will be discussed, as well as scale issues, input data requirements and modelling principles like calibration and validation.

Objectives

At the end of this topic, the student should be able to:

- know of different approaches to hazard modelling;
- understand how models can be used for predictions regarding geo-hazards
- understand the reach and limitations of the various approaches to modelling;
- understand the importance of model calibration and validation;

Contents

- Lectures
- Exercises
- Self study

Prerequisites

Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent).

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS / RS)
- Basic understanding of physics, statistics and mathematics

Compulsory textbook(s)

None

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	18	0	8	6	12	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 theory will be assessed during the combined written examination that also includes the topics Image Interpretation and Data Collection. Project 1 will offer the opportunity to apply the modelling approaches and there it will be graded in the project report (group-work) and during the oral exam (individual).

GH project 1: Hazard Assessment		
Module: 5-7	Module coordinator: Drs. N. Kingma	
Start:	04-01-2010	
End:	05-03-2010	
Level: MSc, PGD	ECTS: 3	U10-AES-115

Introduction

This project will run parallel to the Geo-Hazards topics "Image Interpretation", "Data Collection" and "Empirical Modelling". The aim is to apply the techniques and theory taught during the classes and exercises on a real-world problem. In small groups you will cooperate to identify potential hazards, create a geo-database and carry out a hazard assessment. During the project you will link theory and practice. During the project you will also deal with literature study, project management, presentation and reporting skills, etc.

Objectives

Upon completion of the topic, the student should be able to:

- Extract relevant information from RS-imagery for geo-hazard assessment
- Construct and manage a geo-database
- Carry out a preliminary hazard assessment

Contents

- Self study
- Group work
- GIS- and RS analysis
- Presentation and reporting

Prerequisites

Principles and applications of Remote Sensing and GIS (ITC core modules or equivalent).

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS / RS)
- Basic understanding of physics, mathematics and statistics

Compulsory textbook(s)

See topics: "Image Interpretation", "Data Collection" and "Empirical Modelling".

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6	0	0	70	0	0	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

Group report, group presentation and individual oral exam.

GH topic: Hazard Analysis 2: Process Based Modeling and Applied Hydrology			
Module: 8-10		Module coordinator: Prof. Dr. V. Jetten	
Start:	08-03-2010		
End:	07-05-2010		
Level: MSc, PGD		ECTS: 4	U10-AES-116

Introduction

Many geohazards result from hydrological processes that act as a driving force or trigger. Examples are soil moisture and drought/crop failure, groundwater fluctuations and slope instability, runoff leading to erosion and flooding. Moreover many of these processes are related: a hurricane often leads to storm runoff, flooding, and slope instability, so that we have to deal with multiple hazards. Hazardous processes are spatial in nature so a good knowledge of the landscape (for example by image interpretation) and integration of various data sources with models is needed. The emphasis will be on those aspects of hazardous processes that are needed in risk assessment.

This module will teach you how to predict the frequency and severity of these hazards, based on a simulation of the processes. The module will start with the basics of hydrological processes, making use of land use data, soil physical properties and relief. The theory will be alternated with practical exercises, in which you will learn how to build a water balance model step by step using the PCRaster software. The second part of the model concentrates on hazardous aspects of processes, modelling slope instability, runoff and erosion and flooding, using various models.

To get good model results, sensitivity analysis, calibration and validation are important. Also attention will be given to frequency-magnitude analysis. This will allow you to create meaningful hazard scenarios and may answer "what if" questions.

Objectives

At the end of this topic, the student should be able to:

- Gain process knowledge in a context of modelling (with an emphasis on hydrology triggered or related hazards)
- Understand which landscape factors are important
- Know the strengths and limitations of this type of modelling approach
- Understand the importance of calibration, validation and sensitivity analysis.
- Create scenarios that are important for risk analysis

Contents

- Lectures
- Exercises
- Self study

Prerequisites

Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent); AES-GH Modules 5-7 are a plus.

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS / RS)
- Basic understanding of physics, statistics and mathematics

Compulsory textbook(s)

None

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
24	30	0	20	0	14	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 theory will be assessed during the written examination. Practical assignments will be evaluated and graded.

GH topic: Risk Assessment		
Module: 8-10	Module coordinator: Dr. C.J. van Westen	
Start: 08-03-2010		
End: 07-05-2010		
Level: MSc, PGD	ECTS: 5	U10-AES-117

Introduction

This topic will give an introduction to how the hazard information which has been analyzed in the previous modules can be used for vulnerability and risk assessment. Risk can be defined as the expected losses due to particular hazardous events in a given area and within a given period of time. In order to analyse risk information should be available on (1) the temporal and spatial probability of hazardous phenomena and the expected magnitudes; (2) the types and amounts of elements at risk and their characteristics. The topic introduces you to both qualitative and quantitative approaches for risk assessment, concentrating mostly on hydro-meteorological hazards. The risk assessment focuses on an urban environment and is centered around the RiskCity training package, which guides you through the full process of multi-hazard risk assessment in an urban environment. Emphasis is given to the collection of data using RS, mobile GIS, participatory approaches, etc. as well as the assessment of the vulnerability of e.g. people, buildings, society, etc. It further will deal with different types of risk assessment: specific risk, annual risk, flood risk, landslide risk, multi-hazard risk, etc.

This topic is also offered as a distance education course which will be given to outside participants.

Objectives

At the end of this topic, the student should be able to:

- Understand the principles of risk assessment
- Know the data requirements for a risk assessment
- Know some techniques to do a risk assessment for a particular type of risk.
- Carry out an element-at-risk mapping
- Carry out a vulnerability assessment
- Carry out both qualitative and quantitative risk assessments

Contents

- Lectures
- Exercises
- Self study

Prerequisites

Principles and Applications of Remote Sensing and GIS (ITC core modules or equivalent).

Recommended Knowledge

Basic knowledge of GIS, RS and geo-hazard assessment.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
30	45	0	22	0	22	18

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 theory will be assessed during the written examination. Practical assignments will be evaluated and graded

The end of the topic consists of a final project, where participants have to select one component of risk assessment, related to the RiskCity training package, and work this out during several days, after which a short report and a presentation should be given.

GH project 2: Risk Assessment		
Module: 8-10	Module coordinator: Dr. C.J. van Westen	
Start: 08-03-2010		
End: 07-05-2010		
Level: MSc, PGD	ECTS: 3	U10-AES-118

Introduction

This project will run parallel to the topic "Process-based Modelling" and is an integrated part of the topic "Risk Assessment". It will deal with the analysis and evaluation of risks from natural and man-induced hazards (such as flooding, earthquakes, landslides and technological hazards). The risk can be assessed using qualitative, semi-quantitative or quantitative approaches and ultimately the project will work towards a multi-hazard risk assessment. Such a risk assessment forms an important input for disaster risk management, for the design of development plans and emergency response planning. You will be taken through the entire process of risk assessment and you will learn about hazard assessment, elements at risk mapping and vulnerability assessment and to apply GIS in these analyses.

Objectives

Upon completion of the topic, the student should be able to:

- Understanding the procedure to carry out a multi-hazard risk assessment
- Have insight in the data requirements
- Apply RS for hazard assessment and elements at risk mapping
- Understand the different approaches to risk assessment
- Understand the role of multi-hazard risk assessment in disaster risk management.
- Quantify the effects of mitigation options

Contents

- Group work
- Self study
- GIS analysis
- Presentation and reporting

Prerequisites

Principles and applications of Remote Sensing and GIS (ITC core modules or equivalent).

Recommended Knowledge

- Background in Earth Sciences
- Basics of geo-information science (GIS / RS)
- Basic understanding of physics, mathematics and statistics

Compulsory textbook(s)

See topics: "Process based modelling" and "Vulnerability and Risk Assessment".

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
6	0	0	70	0	0	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

Group report, group presentation and individual oral exam.

Final Project PGD		
Module: 11-12	Module coordinator: Drs. B. de Smeth	
Start: 10-05-2010		
End: 18-06-2010		
Level: PGD	ECTS: 10	U10-AES-137

Introduction

The final project is an integral part of the Applied Earth Science Postgraduate diploma course. It provides course participants an opportunity to apply the knowledge and skills acquired in core and domain modules of the course under (simulated) professional working conditions.

Focus is on the application of advanced survey techniques and data acquisition methods for the generation of stream relevant earth scientific information and understanding. The project also provides an opportunity for the development of 'life skills' (e.g. teamwork, project planning, problem-solving, presentation and communication).

Students will work individually or in small -possibly multi-disciplinary- teams. Each team will plan and carry out a number of tasks according to agreed upon terms of reference.

These tasks can be group- or individual tasks.

Project deliverables include a project report and a documented GIS database.

The specific projects will be chosen in consultation with the course participants and will also depend on the number of participants in each AES Stream.

Objectives

The common learning objectives for the Final Project are described as follows.

Upon completion of this module students should be able to:

- Design and plan a practical work project with or without fieldwork.
- Identify data requirements, collect or generate and process data, present the information required according to agreed upon terms of reference.
- Analyse the data collected, and formulate relevant conclusions and recommendations based on this analysis.
- Present their work to an audience of earth scientists in a convincing way.
- Perform project activities as a professional team.

Contents

Data acquisition/fieldwork and data processing/reporting are considered to be an essential element of applied earth science training. The final project is organized in three phases; preparation, execution and reporting phase.

The set up of the final project is as follows:

Preparation phase

- introduction to the project, presentation of terms of reference;
- identification of project objectives, and planning of project tasks per team;
- review of selected literature, analysis of existing data (RS images, topographical data, geological maps, and other multi-scale, multi-theme data);
- preparation of preliminary/interpretation maps, design of project geo-database;
- development of a plan for field verification and data collection, selection of relevant operations and analysis procedures;

Execution phase

- Practical training in the use of field instruments and mobile GIS/GPS devices combined with field validation of interpretation maps; recording geological, geomorphic and soil field information; and field mapping of relevant surface and subsurface structures and processes. This will probably take place in the Bentheim sandstone quarry near Ahaus 15 km from Enschede.
- Data collection from various sources or data generation e.g. in ITC's GeoScience Laboratory.

Post-fieldwork phase

- processing of the collected or laboratory generated geochemical or spectral data or field observations
- analysis of results and construction of final maps, plots etc.
- preparation of a full technical project report
- presentation (PowerPoint) of results

Prerequisites

AES modules 1 to 8, or equivalent.

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
15	15	0	25	5	15	5

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

Project report and presentation will form the main base for assessment mark but also the individual performance during the execution of the project and in the final presentation will be taken into consideration.

Research Skills		
Module: 11	Module coordinator: Dr. D.G. Rossiter	
Start:	17-05-2010	
End:	04-06-2010	
Level: MSc	ECTS: 5	P10-EDU-103

Introduction

The ITC MSc thesis research phase aims to strengthen your ability to execute scientific research. The success of your thesis research depends, apart from skills and conceptual background in your scientific discipline, also on the ability to adequately structure your research proposal and thesis. This module provides a set of research skills applicable to all MSc students at ITC to improve performance in the subsequent thesis research. It teaches you why research is structured as it is and challenges you to develop the ability to critically review scientific work of yourself and others. You will be trained to analyze the structure, logic and quality of research with examples from your own scientific field. Also you will develop skills to structure scientific research and write proper structured English. The module finally aims to create common understanding of what is expected of a research proposal and how it will be assessed, to allow you to comply with these expectations.

The module is structured as a series of common lectures, with per-course breakout sessions. In addition to the common lectures by Dr. D.G. Rossiter, overall coordinator module 11, delegate coordinators will organize and teach the per-course breakout sessions. Selected topics will be taught by other departmental staff and supporting staff (Library, RC, IT).

Objectives

Upon completion of the module, participants will be able to:

- understand why scientific research is structured as it is,
- recognize and critically assess research quality,
- recognize and follow ethical standards in research,
- find, evaluate, and summarize the most relevant and up-to-date scientific literature to support research, and
- structure an MSc thesis research proposal according to academic expectations.

Contents

- The scientific enterprise and the ITC MSc student's place in it
- Logic and structure of scientific research.
- Inference in various scientific disciplines.
- Literature search, citation and bibliography.
- Abstracting and reviewing scientific research.
- Structured scientific writing and argumentation.
- How to structure an MSc research proposal.
- Ethics and professionalism in research.

Follow-up lectures in the thesis-writing phase (not part of this module) will continue with related themes:

- Research quality and thesis assessment.
- Structuring results, discussion and conclusions
- Graphic presentation in an MSc thesis.

Prerequisites

Before entering module 11 participants have to submit their intended line of research (MSc pre-proposal), based on the available MSc projects presented at the MSc fair (March 11). This includes: choice of topic and rationale, choice of module 12, 13 and 14-15, available datasets, (optional) fieldwork planning and envisaged MSc supervisors.

At the start of module 11 participants must be able to:

- Present and discuss research in public (orally, supported by presentation slides);
- Communicate about technical subjects in written English;

Besides participants are expected to have:

- A background in at least one relevant scientific field;
- A critical/creative attitude.

Recommended Knowledge

Not applicable.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
31	4	0	0	0	98	11

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

- (1) Full participation in (group)discussions is expected;
- (2) Further, the mark is derived from three written assignments:
 1. Literature skills: (i) Finding relevant literature from specified information resources, (ii) entering references to these in a bibliographic database, (iii) organizing the main points into a coherent paragraph, and (iv) formatting a reference list from the bibliographic database;
 2. Summarizing and abstracting an important scientific paper in the research field of your course;
 3. Arguing a scientific position (importance of a research topic) in correct, compact and direct structured technical English.

Advanced Topics		
Module: 12-13	Module coordinator: Dr. M.J.C. Weir	
Start:	07-06-2010	
End:	16-07-2010	
Level: MSc	ECTS: 10	P10-EDU-104/105

Introduction

Modules 12 and 13 form the backbone of the third Block of the MSc programme. Following module 11 on research skills and before working together in research themes during modules 14-15, students follow two advanced subjects to equip them with specific research tools, methods and applications that are important for their envisaged MSc research. In selecting these two topics, participants therefore have to make a logical choice that fits to the envisaged MSc research to be carried out during Block 4 (MSc research phase; modules 16-23). The choice is made, and explained, in the MSc pre-proposal that has to be submitted after the MSc fair (March 10th 2010) and before the start of module 11 (exact date and format to be specified).

The final list of choices for the 2009/10 courses will be made available no later than January 2010, after evaluation of the 2008/09 courses and following final approval by the Academic Board. The offered subjects may be updated or revised, and new subjects may be added and some may be dropped.

In this generic study guide description the 28 advanced subjects of the 2008/09 course are mentioned to show the range of subjects on offer. Descriptions of these modules can be found in the "Search module descriptions" option on internet:

<http://www.itc.nl/education/courses/modules.aspx>, select study guide = 2008-2009, level = MSc and module = 12, respectively 13.

Objectives

Specified per advanced subject.

Contents

Module 12:	Title:
M09-EOS-100	Advanced image analysis
M09-EOS-101	Geostatistics
M09-EOS-103	Laser scanning and InSAR
M09-ESA-100	Essentials of physical process modelling
M09-ESA-101	Hyperspectral Remote Sensing
M09-ESA-102	Geophysics and 3D geo-visualization of the subsurface
M09-GIP-100	Design and Implementation of Spatial Databases
M09-GIP-101	Time series
M09-NRS-100	SAR Remote Sensing
M09-PGM-100	Managing geoinformation systems in the public sector
M09-PGM-102	Spatial planning support systems and scenario development
M09-PGM-103	Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) applying Spatial Decision Support tools
M09-WRS-101	Quantitative retrieval of geo(bio)physical parameters from remote sensing data
M09-WRS-102	Use of GEONETCast environmental data streams for climate, water and environmental studies

Module 13:	Title:
M09-ESA-103	Multihazard Risk Assessment
M09-ESA-104	Data analysis in earth, water and natural resources studies
M09-ESA-105	Soil and Water conservation
M09-EOS-104	3D Geoinformation from imagery
M09-EOS-105	Advanced statistics
M09-GIP-102	Design and implementation of Geoinformation Services for SDI
M09-GIP-103	Use, users and usability
M09-NRS-101	Spatial modelling of biological Ecosystem Properties
M09-PGM-101	Spatial change and spatial interaction modelling
M09-PGM-104	Applying research methods for public sector geoinformation management
M09-PGM-105	Participatory GIS – principles and applications
M09-PGM-106	Scenario analysis and collaborative decision support
M09-WRS-100	Large scale process modeling and data assimilation
M09-WRS-103	Climate change impacts and adaption – Analysis and monitoring techniques of climate change

Prerequisites

MSc modules 1-11 (and other specifications as given per subject).

Recommended Knowledge

Specified per advanced subject.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
32	40	0	60	60	80	16

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)

Important:

The numbers above are calculated for two modules.

Assessment

Specified per advanced module. Note that the assessments of Modules 12 and 13 must both result in a mark.

Research Themes/MSc Qualifier		
Module: 14-15	Module coordinator: Dr. M.J.C. Weir	
Start: 19-07-2010	<ul style="list-style-type: none"> ▪ Research project coordinators appointed per research theme ▪ 2 MSc supervisors appointed beforehand for each participant 	
End: 27-08-2010		
Level: MSc	ECTS: 10	P10-EDU-106

Introduction

Modules 14 and 15 form the last part of Block 3 of the MSc programme. While Modules 11 to 13 have provided the students with research methods and tools, the last two modules focus on the research themes of ITC. These themes form the subject framework and organizational structure in which MSc students conduct their individual MSc research in Block 4 of the MSc programme (modules 16-23). At the end of Module 15, a Thesis Admission Committee decides whether or not a student is admitted to Block 4.

Each ITC research theme offers one or more projects for Module 14 and 15, where possible together with one or more other themes. The general structure is the same; the content will be theme specific, and, where possible, inter-disciplinary. Research themes are free to fill this in within the boundaries described in this module description.

The purpose of Modules 14 and 15 is to deepen the knowledge and skills of students within the research theme and to help students to define their own MSc research proposal.

The student has to make a choice for a certain research theme, based on his/her envisaged MSc thesis topic. The choice is made, and explained, in the MSc pre-proposal that has to be submitted after the MSc fair (March 10th 2010) and before the start of module 11 (exact date and format to be specified). The following 15 themes are available:

Education Unit 14/15:	Title Research theme	Research theme leader
U09-NRS-101	Biodiversity in fragmenting landscape	Prof. A.K. Skidmore
U09-NRS-102	Carbon-cycle and climate change	Dr. Y. Hussin
U09-ESA-100	Disaster management	Prof. V.G. Jetten
U09-ESA-101	Earth systems science	Prof. F.D. van der Meer
U09-NRS-103	Food security and environmental sustainability	Prof. E.M.A. Smaling
U09-PGM-100	Governance and Integrated Spatial Assessment	Prof. A. van der Veen
U09-PGM-101	Informed multilevel governance of urban regions	Prof. Y. Georgiadou
U09-PGM-102	Land administration for informed governance	Prof. J. Zevenbergen, Prof. P. van der Molen
U09-WRS-100	Managing water scarcity	Dr. M. Lubczynski
U09-GIP-100	Spatial data infrastructure technology	Dr. R.A. de By
U09-GIP-101	Spatio-temporal data integration and visualization	Prof. M.J. Kraak
U09-PGM-103	Sustainable urban-regional dynamics	Prof. F.A.M. van Maarseveen
U09-EOS-100	Stochastic methods for image mining and data quality	Prof. A. Stein
U09-EOS-101	Utilisation of sensor developments for efficient topographic mapping	Prof. M.G. Vosselman
U09-WRS-101	Water cycle climate	Prof. Z. Su, Prof. W. Verhoef

For more information about the content and scope of the ITC research themes, please visit: <http://www.itc.nl/research/themes.asp>

Objectives

Upon completion of these modules students will be able to:

1. Write an MSc research proposal.
2. Define ways how to tackle a scientific problem and structure research.
3. Place research projects in a wider scientific and societal context.
4. Structure scientific research to the specifications of the scientific discipline.
5. Meet quality standards and excellence in research.
6. Present scientific information in written English at a standard acceptable to the scientific community.

Contents

Two main activities run parallel in Modules 14 and 15:

1. A group research project,
2. Finalizing the research proposal for the individual MSc thesis.

1. Group research project

The purpose of the group project is:

- To let the student place his/her own MSc research project and research interests in a wider scientific context.
- To give the student an opportunity to practise – under supervision of a tutor - conducting a research project before starting to work on his/her individual MSc research project.
- To give the student an opportunity to practise undertaking research in a team.
- To give student the opportunity to share their knowledge in a multi-disciplinary context.

These activities are considered an important preparation for conducting the individual MSc research in Block 4, as well as for the student's future professional academic working practice in which projects are often conducted in multi-disciplinary groups.

Research projects can be defined by one or several research themes. The projects are defined with a view to catering for a variety of research approaches and interests, as well as the relevance of these to society. Projects are described with a title, a problem definition, and, if appropriate, the available dataset. The student group, consisting normally of a maximum of five students, is responsible for working this out into various activities according to an agreed plan. The student group has the freedom to make its own choices, supported by a tutor. The available projects will be made known early in 2010 in order to give the participants the opportunity to select a project that matches their research interest. The choice has to be submitted before the start of module 11 (exact date to be specified) and should be justified within the MSc pre-proposal.

In a plenary session at the start of module 14, the Principal Investigator of the research group will introduce the various MSc subjects and their interrelation in the framework of the research of his/her group, and introduce the research assignments. A tutor will be appointed during module 14-15 to guide each student group. The tutors will convene plenary sessions (in principle per research group) to monitor the progress of all participating students and to exchange experiences in a discussion forum.

2. Finalizing the research proposal

The MSc research proposal is finalized by the student in mutual agreement with his/her MSc supervisors, appointed in Module 11. The research proposal should be a logical and ordered exposition of the envisaged research (as introduced in Module 11), including data availability, (fieldwork) methods, a flowchart, and time planning. In the last week of Module 15, the research proposal is presented before a Thesis Admission Committee (see MSc assessment regulations paragraph 5.1.1). When presenting the proposal, the student must also satisfy the Thesis Admission Committee that all the required data is available or, if not, that steps (including fieldwork if appropriate) will be taken to acquire these data in time. Likewise, requirements for hardware and/or software should be specified to ensure that these can be made available as required. Acceptance of the proposal is a prerequisite for the start of the individual research (Modules 16-23). The MSc student will draft a supervision plan with the two appointed MSc supervisors.

Prerequisites

Successful completion of Modules 1 to 13 of the MSc curriculum.

Because the research themes will be taught at advanced level, it is necessary to have a basic level of knowledge in the chosen research theme. Consequently, students who want to choose a research theme which differs from their choice in Blocks 1 and 2, have to provide satisfactory evidence that they have the right background.

Recommended Knowledge

To be specified per research theme.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
10	0	0	70	(120)	16 (+32)	(40)

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)

Important:

The numbers above are calculated for two modules: 96 hrs (= 2 weeks) are allocated for the group research project, and 192 hrs (= 4 weeks) are reserved for the MSc proposal (=numbers between brackets).

Assessment

- Group report of the research project.
- Individual written reflection report on the group research project.
- Individual MSc research proposal (written and oral presentation).

MSc Research and Thesis Writing		
Module: 16-23	Module coordinator: Dr. M.J.C. Weir	
Start: 06-09-2010	<ul style="list-style-type: none"> ▪ Course directors of all MSc courses ▪ 2 MSc supervisors per student 	
End: 25-02-2011		
Level: MSc	ECTS: 40	U10-EDU-107

Introduction

The final stage of the MSc course is dedicated to the execution of an individual research project. Each student works independently on an approved research topic (see module 15) connected to one of the 15 research themes of ITC. In this project, the students further develop their research skills, interact with their fellow students, PhD's and staff members and, finally, demonstrate that they have achieved the course objectives for the Master of Science degree by research, on a satisfactory academic level.

Objectives

The student must be able to:

- Define, plan and execute a research project dealing with a problem related to the application of geo-information and earth observation in a domain that suits his/her background and course followed.
- Write a concise, logical and well structured thesis describing the key elements of the research process, the findings and recommendations.
- Orally present and defend the work done before the Thesis Assessment Board.

Contents

Based on the pre-proposal handed in before module 11, and the final accepted research proposal prepared in module 15, the student will carry out the planned activities. The students will be provided with guidelines for the thesis early in the course (specifically in module 11). Regular individual progress meetings with the supervisors will be held to monitor the progress on the research and thesis writing, and records of the progress will be kept. The supervisors keep the course director informed about the progress.

The activities normally include:

- Describe and define a problem statement and research topic and its research margins.
- In-depth literature review, including assessment of the usability of literature and previous research.
- Collection of relevant on-line and archived data.
- If appropriate, preparation and execution of fieldwork to collect primary data required for the research.
- Data processing and analysis and, if deemed necessary, adjustment of the research plan in consultation with the supervisors (based on sound arguments).
- Active participation in Institute seminars and *capita selecta* of the research theme under which the MSc research resorts.
- Mid-term presentation (first week of November).
- Preparation of the final manuscript of the MSc thesis (=hardcopy thesis and CD-ROM with thesis, appendices and full dataset including the original data and results).
- A critical review of the quality, use and usefulness of the data and results, as well as the learning process.
- Oral presentation and defence of the MSc thesis before the Thesis Assessment Board, all in accordance with the relevant paragraphs of the MSc regulations.

Prerequisites

Successful completion of MSc modules 1-15, and proven ability to undertake independent research (ref. to par. 5.3.1. of the MSc regulations).

Recommended Knowledge

During the research phase, the students can specialise further in their own field of expertise.

Compulsory textbook(s)

None.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
0	0	0	0	1136	0	16

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

A Thesis Assessment Board (TAB) will assess the individual assessment based on the written thesis and a presentation plus oral defence. The assessed aspects are:

- Research skills;
- Contribution to the development of the scientific field;
- Ability to work independently;
- Critical and professional thinking;
- Scientific writing;
- Presentation and defence.

For further details on the regulations and thesis assessment, see:

- ITC Regulations for courses leading to an ITC Master of Science (MSc.) Degree (September 2009);
- Instructions for Thesis Assessment Board.

Assessment Regulations

EA/4330

**ITC REGULATIONS FOR COURSES LEADING TO AN
ITC MASTER OF SCIENCE (MSc.) DEGREE
OR
ITC POSTGRADUATE DIPLOMA**

– September 2009 –

1. Range of application
2. Management, structure and organization of the MSc. and Postgraduate Diploma course
3. Admission to the course and exemptions
4. Assessment of modules (excluding research period and final assignment)
 - 4.1 Organization of module assessment
 - 4.2 Feedback to participants and re-sits
5. Research orientation and research period (MSc. course)
 - 5.1 Research orientation (block 3)
 - 5.2 The individual research period and thesis (block 4)
 - 5.3 Supervision of the proposal phase and the research work
 - 5.4 Admission to the research period
 - 5.5 Submission of the thesis
 - 5.6 Thesis examination
 - 5.7 Access to the thesis
6. Final Assignment (Postgraduate diploma course)
 - 6.1 The Final Assignment and result
 - 6.2 Supervision of the Final Assignment
 - 6.3 Submission of the Final Assignment result
 - 6.4 Assessment of the Final Assignment
7. Assessment of MSc. degree and Postgraduate diploma
8. Awards and certification
9. Early termination of the course
10. Student appeal procedures

Appendix:

Bodies and persons involved in management and quality assurance of the MSc. course and the Postgraduate diploma course

These ITC Regulations for the Master of Science (MSc.) degree and Postgraduate diploma courses were approved by the Rector and the Academic Board on 17 September 2008. These regulations apply to all courses commencing September 2009 onwards and replace all former ITC Regulations for Master of Science degree Courses and Regulations for Postgraduate diploma courses.

1. Range of application

- 1.1. These assessment regulations apply to all courses leading to an ITC Master of Science (MSc.) degree or a Postgraduate diploma (PGD) starting from September 2009 onwards and replace all previous ITC Regulations for Master of Science degree Courses and ITC Regulations for Postgraduate diploma courses.
- 1.2. The MSc. and Postgraduate diploma course can be an ITC course only (fully taught at ITC) or a joint course (partly taught by one or more of ITC's partners 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 course.
- 1.3. In most cases where the MSc. / Postgraduate diploma 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 of Science degree or ITC Postgraduate diploma'. The Course Director of the course concerned will inform the participants which assessment regulations and procedures apply.
- 1.4. Per 1 January 2010 ITC will be integrated in and will become a Faculty with special status of the University of Twente. This integration might have consequences for the assessment regulations and might lead to changes in these assessment regulations during the course.
- 1.5. 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.
- 1.6. 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 MSc. and Postgraduate diploma course

- 2.1. The MSc. course is organized into four blocks with a total of 23 modules and one or two starting weeks for introductory and remedial activities.

Block 1: modules 1-4

Block 2: modules 5-10

Block 3: modules 11-15

Block 4: modules 16-23

The first year of three blocks and 15 modules consists of coursework. The last 6 months (block 4; 8 modules) focus on individual research.

The Postgraduate diploma course consists of the first two blocks (10 modules) of the MSc. course, one or two starting weeks and a Final Assignment of four weeks duration.

- 2.2. The duration of the MSc. course is 18 months fulltime. The duration of the Postgraduate diploma course is nine months fulltime. Participants in both courses may spread the modules over a maximum of three and a half years.
- 2.3. The formal curriculum of the MSc. course and the Postgraduate diploma 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 MSc. participant to receive the MSc. degree. The Academic Board decides on whether the participant in the Postgraduate diploma course will receive the Postgraduate diploma.
(See also the appendix 'Bodies and persons involved in management and quality assurance of the MSc. course and the Postgraduate diploma 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,
 - 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 MSc. and Postgraduate diploma 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 MSc. degree / Postgraduate diploma to be received on successful completion of the course
 - The course-specific conditions relating to that MSc. degree / Postgraduate diploma
 - 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 course and exemptions

- 3.1. Applicants who meet the entry requirements for the MSc. / Postgraduate diploma course, as stipulated in the current course brochure, may be registered for the MSc. / Postgraduate diploma course at the discretion of the Course Director.
- 3.2. Participants in the Postgraduate diploma course who wish to take the whole MSc. course have to re-apply for the (second part of the) MSc. course. In such cases the maximum time between the starting date of the Postgraduate diploma course and the graduation date of the MSc. course is three and a half years (see rule 3.4).
- 3.3. 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 (MSc. course) or the Academic Board (PGD course) and, in case of exchange for a module in another course, approval of the Course Director of that course.
- 3.4. 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 MSc. / Postgraduate diploma course and
 - (2) No longer ago than three and a half years before the participant is expected to complete the MSc. / Postgraduate diploma course.

At least 50% of the MSc. / Postgraduate diploma course has to be taken to be eligible for the MSc. degree / Postgraduate diploma. Therefore, exemption can be given for a maximum of 11 modules of the MSc. course and for a maximum of five modules of the Postgraduate diploma course.

Requests for exemption that do not meet these conditions will be considered on an individual basis, at the discretion of the Degree Assessment Board (MSc. course) or the Academic Board (PGD course). In such cases, exemption can be given for a maximum of eight modules in the MSc. course and four modules in the Postgraduate diploma course.

Exemption can never be given for (part of) the research work or Final Assignment.
- 3.5. In exceptional cases, a participant may also exchange a module of which the content has not been mastered for a module given in another course, provided that the Course Director of that course approves. Such an exchange is up to a maximum of two modules and subject to the approval of the Degree Assessment Board (MSc. course) or Academic Board (PGD course).
- 3.6. 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 participants who have successfully completed a specific curriculum in the partner institute can be given direct admission to a later part of the MSc. or Postgraduate diploma course.

4. Assessment of modules (excluding research period and final assignment)

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, thesis), one overall assessment is allowed.

Up to three of the first 11 modules in the MSc. course may be assessed by 'completed / fail'. The other module assessments must result in a mark.

The assessment of modules 12 and 13 may not be based on participation only and must result in a mark.

- 4.1.2. For admission to the research part (see rule 5.3.1) and for the calculation of the average of all modules (see rule 7.2), 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 shall 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 will 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 9.5).
- 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. Research orientation and research period (MSc. course)

5.1. Research orientation (block 3)

- 5.1.1. At a specified date before the start of Module 11 participants must submit:
- (1) The research theme they will join,
 - (2) A motivated choice of modules 12 and 13, and
 - (3) The preliminary title of the individual MSc. research topic and its main thrust.

The choices will be assessed by the Course Director and the research theme leader concerned (or delegate).

Approval of these choices leads to admission to the research theme and two MSc. supervisors will be appointed (see rule 5.3.1).

- 5.1.2. The final MSc. research proposal (approximately 8 pages) must be presented in module 15.
- 5.1.3. Participants have freedom to choose from the advanced subjects on offer in modules 12 and 13, with the limitation that modules will only be given when sufficient participants will participate.

5.2. The individual research period and thesis (block 4)

- 5.2.1. The MSc. research period focuses on individual research. The research requires that the MSc. participant carries out the research and reports on progress to the supervisors according to an agreed schedule for the research and preparation of the thesis.
- 5.2.2. The research work will be assessed on three occasions:
- (1) The detailed research proposal and presentation, leading to admission / no admission to the research period (end of module 15).
 - (2) The mid-term presentation. No mark is given. The participant receives feedback from the supervisors. In the case of weak performance, the participant will receive a written warning from the Course Director (see rule 9.1).
 - (3) The assessment and oral examination of the thesis.
- In addition to these formal assessments, the participant will receive feedback on his/her performance from the supervisors throughout the research period.
- 5.2.3. A participant not presenting the (draft) research proposal, not making the mid-term presentation, not submitting the thesis 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.

- 5.2.4. The thesis, approximately 50 pages of text (approximately 350 words per page and presented in the standard ITC format for theses), excluding appendices, shall constitute an ordered, logical and critical description of the research and should afford evidence of reasoning power, critical attitude, competence in the scientific discipline (application and/or development of knowledge and skills), and knowledge of relevant literature.
- 5.2.5. The thesis 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.
- 5.2.6. With the explicit approval of the supervisor, a participant may be permitted to incorporate in his/her thesis a limited amount of unpublished work undertaken by the participant prior to the start of the research. A participant may not incorporate in his/her thesis material which has been submitted for achieving the award of a degree from any other educational institution.
- 5.2.7. 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 Thesis Assessment Board will decide not to assess the thesis. This means that the MSc. degree cannot be awarded (see also rule 9.3 and 9.5).
- 5.3. Supervision of the proposal phase and the research work
 - 5.3.1. In module 11, in consultation with the research theme leader and the MSc. participant, the Course Director shall recommend a primary and secondary supervisor to the supervisor's department(s). PhD students and AiO's may be involved in the supervision as advisor and support the work of the supervisors. Supervisors and advisors are appointed by the management team of the department.
 - 5.3.2. The two supervisors and, if applicable, the advisor 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 MSc. participant in the formulation of a detailed research proposal.
 - (2) Establish a schedule of regular supervisory meetings with the MSc. 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 research.
 - (4) Provide feedback on draft written work, normally within 10 days of receipt.
 - (5) Where appropriate, forward 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 9.1 and 9.2).
- 5.3.4. If a MSc. 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 research 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. Admission to the research period
 - 5.4.1. For admission to the research part of the course, at least all but two of the previous modules (see rule 7.2 to see which modules are to be included) must have been successfully completed and no mark below 50 is allowed. The second requirement for admission to the research part, which is as important as the marks obtained in previous modules, is the ability to undertake independent research. This ability will be developed and assessed during the first 15 modules and finally assessed on the basis of the detailed, written and orally presented, research proposal (end of module 15).
 - 5.4.2. The Course Director will nominate, and the Degree Assessment Board will approve, a Thesis Admission Committee. This Committee will assess the proposal and the presentation by the participant. The Thesis Admission Committee is accountable to the Course Director.
 - 5.4.3. Each Thesis Admission Committee has 3 members: the research theme leader or delegate (chair), the first supervisor and the second supervisor (or delegate). The Course Director and involved PhD students or AiO's (see 5.3.1) may be present as advisors.
 - 5.4.4. The research proposal will be assessed based on the written proposal, a presentation and oral defence. The presentation and oral defence have a duration of a half hour. The participant will receive the result and remarks in writing.
 - 5.4.5. The oral defence of the research proposal is open and will be announced as such.

In exceptional cases the Course Director can decide to have the oral defence of individual participants closed to observers other than ITC staff.
 - 5.4.6. When the Thesis Admission Committee is of the opinion that the research proposal is not of a level required for the start of the individual research period, the participant will receive feedback and will have a second opportunity to defend a revised proposal within two weeks. In case the second proposal presentation is not satisfactory, the candidate will not be admitted to the individual research period.

- 5.4.7. A participant who is not eligible for admission to the individual research period of the course but has completed modules 1 to 14 of the MSc. course successfully (see rule 8.1) will receive a Postgraduate diploma.
- 5.5. Submission of the thesis
- 5.5.1. The participant must submit a well-organized copy of all digital files associated with the research work on DVD, and a hard-copy of graphic output, at least two weeks before the examination date or as specified by the Course Director.
- 5.5.2. ITC will produce sufficient printed copies of the thesis, including two for the participant. The participant must bring one of his/her copies of the thesis to the oral examination.
- 5.5.3. One copy of the thesis will be sent to each member of the Thesis 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.
- 5.5.4. Where work submitted has been done in cooperation with others, the supervisor must submit a written statement to the Thesis Assessment Board indicating the extent of the participant's share of the work.
- 5.6. Thesis examination
- 5.6.1. For the thesis examination, the Course Director nominates and the Degree Assessment Board approves a separate Thesis Assessment Board for each participant. The Thesis Assessment Board is accountable to the Course Director.
- Each Thesis Assessment Board has 3 to 5 members: one or both supervisor(s), an ITC professor or associate professor in a relevant discipline, an external examiner and, if necessary, other staff members of the ITC. The involved AiO or PhD student (see 5.4.1) and the Course Director may be present as advisors.
- In many cases, the external member comes from outside ITC, preferably being an academic staff member of a university. In the remaining cases, the external member comes from an ITC department that does not play a major role in the course and research theme.
- The Thesis Assessment Board is chaired by the ITC (associate) professor. In exceptional cases one of the other members, but not the first supervisor, can be the chair.
- 5.6.2. The thesis examination consists of the assessment of the thesis and the oral examination that includes a presentation and defence. The oral examination has a duration of one hour.
- 5.6.3. The Course Director assigns a date for an oral examination and informs the participant at least one month in advance of this date.

- 5.6.4. All members of the Thesis Assessment Board shall read and assess the quality of the thesis as an ordered, logical and critical exposition of research work in the approved field.

A minimum of three members of the Thesis Assessment Board must be present at the oral examination. (In case the ITC (associate) professor cannot attend, Head Education will appoint another ITC (associate) professor to replace him or her.) These members of the Thesis Assessment Board will assess the participant's reasoning power, critical attitude, competence in the scientific discipline, and knowledge of the relevant literature, will raise questions concerning the thesis and will decide on the mark.

- 5.6.5. 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.

- 5.6.6. On the basis of the assessment of the participant the Thesis Assessment Board shall take one of the following decisions:
- (1) The thesis 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 thesis, the thesis is satisfactory. One single mark is given, subject to the corrections in the thesis being made.
 - (3) The thesis is not satisfactory and is given the FAIL grade.

- 5.6.7. No changes may be made in the thesis after submission for the thesis examination, only an errata list may be added. If the Thesis Assessment Board requires minor corrections to the thesis, 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 thesis is to be re-examined by the Thesis Assessment Board.

- 5.6.8. Extensions to the research period can be given before the thesis is submitted and/or as result of the thesis examination. In case the participant does the research work at a distance, extension can only be given before the thesis is submitted.
- Extensions will be given only when:
- (1) Funding for the extension is available,
 - (2) The main cause of the unsatisfactory level of the thesis has been beyond the control of the participant (at the discretion of the Course Director),
 - (3) The extension could lead to an acceptable thesis and re-examination (at the discretion of the Thesis Assessment Board)

The participant will take the initiative and apply in writing for extension. If the Course Director is of the opinion that the second and third conditions are met, he/she will forward the request to Head Education for decision.

- 5.6.9. The maximum total duration of extensions to the research period is three months. Extensions are allowed only when the participant stays at ITC or, in the 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 thesis in the home organization and since the MSc. course may be spread over a period of maximum three and a half years (see rule 2.2) they may work on the thesis until about a month before the end of the three and a half year period. In such cases, no extensions are possible.

5.7. Access to the thesis

5.7.1. The primary function of the Institute is the development and dissemination of knowledge. Theses are lodged with the Institute Librarian and shall be made available for consultation, inter-library loan and photocopying.

Theses that meet the following criteria will also be made available in digital format at the ITC website:

- (1) Have been awarded a mark of 75 or more
- (2) Contain no material of which the copyright rests with third parties
- (3) Contain no confidential data or information.

5.7.2. Any staff member who publishes results from MSc. research work or the related thesis is obliged to make a proper reference to the MSc. participant's work.

6. Final Assignment (Postgraduate diploma course)

6.1. The Final Assignment and result

6.1.1. The Final Assignment period focuses on the application of knowledge, methods and techniques in the subject of the course to the task performed or to the topic investigated. Depending on the course, the Final Assignment will be done individually or in small groups.

- (1) At the start of the Final Assignment period, participants will receive terms of reference from supervising and coordinating staff.
- (2) Subsequently, participants will have to plan and carry out the assignment according to the terms of reference.
- (3) Part of the output of the assignment will be a final report and a documented database.
- (4) The output of the assignment will be presented and discussed in public.

6.1.2. A participant or group not completing the Final Assignment within the specified time, will be considered to have failed. Only in exceptional cases and for reasons beyond the control of the participant/group (at the discretion of the Course Director), the participant/group may apply in writing for a new opportunity to meet the above requirements.

6.1.3. A participant or group may not incorporate material that has been submitted for achieving certification from any other educational institution, in the Final Assignment result.

6.1.4. 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/group's own work.

If material from other work is incorporated verbatim, without proper acknowledgement of the source (plagiarism), the Course Director may decide that the Final Assignment will not be assessed. This means that the Diploma cannot be awarded.

6.2. Supervision of the Final Assignment

6.2.1. The coordinator of the Final Assignment period, in consultation with the Course Director, will set up a scheme indicating which staff is available for consultation and supervision throughout the Final Assignment period. The supervising staff have to be appointed by the management team of their department.

6.2.2. The supervising staff shall:

- (1) Provide the participant/group with clear terms of reference.
- (2) Establish a schedule of supervisory meetings with the participant/group.
- (3) Provide general advice and guidance on the execution of the Final Assignment.
- (4) Provide feedback on work, normally within three days of submission.
- (5) Forward, where appropriate, any comments on the performance of the participant(s) to the Course Director.
- (6) Advise 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 9.1 and 9.2).

6.2.3. If a participant/group considers that he/she is not receiving the quality of supervision required in the regulations, the participant/group should seek action from the Course Director.

6.3. Submission of the Final Assignment result

6.3.1. The participant/group must submit a well-organized copy of all digital files associated with the Final Assignment work on DVD, and copies of hard-copy graphic output, to the supervising staff on the date of the Final Assignment assessment or as specified by the coordinator of the Final Assignment period in consultation with the Course Director.

6.3.2. Where the Final Assignment has been executed in groups or where individual Final Assignment work submitted has been executed in cooperation with others, the supervisor(s) must provide a written statement, indicating the extent of the share of the work that each participant has done.

6.4. Assessment of the Final Assignment

6.4.1. Participants will be assessed individually based on the output of and the presentation of the Final Assignment.

6.4.2. The Course Director assigns a date for the Final Assignment assessment and informs the participant/group of this date at least two weeks in advance.

- 6.4.3. Criteria for the assessment of the Final Assignment will be provided at the start of the Final Assignment period, i.e. at the time of providing the participants with the terms of reference for the final assignment.
- 6.4.4. The Final Assignment result will be assessed by two or three staff members: at least one (associate) professor in a relevant discipline and at least one staff member who has been involved in the supervision during the execution of the Final Assignment.
- 6.4.5. The presentation of the Final Assignment is open and will be announced as such. In exceptional cases the Course Director can decide to have the presentation of individual participants closed to observers other than ITC staff.
- 6.4.6. On the basis of the assessment of the participant(s) the assessing staff shall take one of the following decisions:
- (1) That the Final Assignment is satisfactory. One single mark is given.
 - (2) That subject to minor corrections (that can be implemented within three working days and implemented before the official end of the course) in the Final Assignment result, the Final Assignment is satisfactory. One single mark is given, subject to the corrections in the Final Assignment result being made.
 - (3) The Final Assignment is not satisfactory and is given the FAIL grade.
- 6.4.7. In exceptional cases extension may be given for the Final Assignment work, but only before the Final Assignment assessment and only when:
- (1) Funding for the extension is available, and
 - (2) The main cause of the unsatisfactory level of the Final Assignment has been beyond the control of the participant/group, at the discretion of the Course Director.
- 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.
- 6.4.8. Extensions have a maximum duration of 50% of the standard duration of the Final Assignment. Extensions are only allowed when the participant/group stays at ITC.

This rule does not apply to participants who study part-time. They are allowed to work on the Final Assignment in the home organization until the end of the period of three and a half years counting from the official starting date of the course (see rule 2.2). In such cases, no extensions are possible.

7. Assessment of MSc. degree and Postgraduate diploma

- 7.1. On the basis of the assessment results of the participant, the Degree Assessment Board decides whether the participant will be awarded the MSc. degree.

On the basis of the assessment results of the participant, the Academic Board decides whether the participant will be awarded the Postgraduate diploma.

In case the Degree Assessment Board (MSc. course) or Academic Board (PGD course) decides that the MSc. degree or Postgraduate diploma will not be awarded, the Course Director will decide whether the participant will be awarded a Certificate or Certificate of Attendance.

- 7.2. For the award of a MSc. degree the average of all module marks (including the thesis that counts for 8 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 thesis must have a mark of at least 60.

The criteria for the award of a Postgraduate diploma are:

- (1) The average of all final module marks must be at least 60. When a module is assessed with 'completed' or 'fail': a 'completed' will not be included in the average, a 'fail' will be counted as a mark of 50. In case of one overall assessment for combined modules, the overall mark will be given to each separate module, before calculation of the average.
- (2) No more than two of the modules may have a mark below 60. No final module mark below 50 is allowed.
- (3) The final assignment must have a mark of at least 60.

Only results of modules that are part of the formal curriculum of the MSc. or Postgraduate diploma 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 7.2) 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 (MSc. course) or Academic Board (PGD course). (See rule 3.4.)

- 7.3. To be entitled to receive a MSc. degree or Postgraduate diploma with distinction the average of all module assessments (see rule 7.2 which modules are to be included) must be 80 or above. The thesis or Final assignment must have a mark of 80 or above. No marks below 70 or 'fails' are allowed.

Participants who have made changes in the formal curriculum of their MSc. or Postgraduate diploma course (exemptions or exchanged modules) that affect more than four (MSc. course) or two (PGD course) modules are not entitled to receive a MSc. degree or Postgraduate diploma 'with distinction'.

- 7.4. The Degree Assessment Board (MSc. course) / Academic Board (PGD course) shall take one of the following decisions:
- (1) That the thesis / final assignment and overall course performance of the participant are satisfactory. The degree of MSc. / Postgraduate diploma shall be awarded.
 - (2) That the thesis / final assignment and overall course performance of the participant are such that the MSc. degree / Postgraduate diploma shall be awarded "with distinction".
 - (3) That subject to minor corrections in the thesis / final assignment, the thesis/ final assignment and overall course performance are satisfactory. The degree of MSc. / Postgraduate diploma shall be awarded subject to the corrections in the thesis / Final Assignment result being made before the official end of the course.
 - (4) For MSc. candidates: That the research work / final assignment and/or overall course performance are not satisfactory. The degree of MSc. shall not be awarded. The participant will receive a Postgraduate diploma.

For Postgraduate diploma course participants: That the final assignment and/or overall course performance are not satisfactory. The Postgraduate diploma shall not be awarded. The participant will receive a Certificate.

8. Awards and certification

- 8.1. A "**Master of Science degree**" will be awarded to a participant who has been officially admitted to a MSc. course (as approved by the Academic Board) and has fulfilled the assessment requirements of that course.

A "**Postgraduate diploma**" will be awarded to a participant who has been officially admitted to a PGD course (as approved by the Academic Board) and has fulfilled the assessment requirements of that course.

A "Postgraduate diploma" ('with distinction' will not be possible in this case) will also be awarded to a participant who (1) has been officially admitted to a MSc. course, (2) has not been admitted to the research period or has failed the thesis, and (3) has completed modules 1 to 14 of the MSc. course successfully (average of all module marks is at least 60, not more than two marks between 50 and 60 and no marks below 50).

A "**Certificate**" will be awarded to a participant who (1) has been officially admitted to a MSc. course or Postgraduate diploma course but has not fulfilled all assessment requirements for that course, and (2) who has fulfilled the assessment requirements of at least one summatively assessed module of that MSc. or Postgraduate diploma 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”** will be given to participants who have been officially admitted to a MSc. course or Postgraduate diploma 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 MSc. degree or Postgraduate diploma.

- 8.2. MSc. degrees and Postgraduate diplomas are issued under the responsibility of the Rector. Certificates and Certificates of Attendance are issued under the responsibility of the Course Director.
- 8.3. MSc. degrees and Postgraduate diplomas are signed by the Rector of the ITC and Head Education. Certificates and Certificates of Attendance are signed by the Course Director.
- 8.4. MSc. degrees are accompanied by a Diploma Supplement. The Diploma Supplement describes the nature, level, context, content and status of the MSc. degree and the MSc. course. The Course Record (see 8.4) is included in the Diploma Supplement.
- 8.5. MSc. degrees, Postgraduate diplomas 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.
- 8.6. 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 of 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”).

9. Early termination of the course

- 9.1. 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 MSc. Degree / Postgraduate diploma without a significant improvement in performance, the participant shall be advised in writing by the Course Director of the situation and the implications. (Oral or written advice by the Course Director may not be given when the concern arises after the mid-term presentation of the thesis or after the approval of the Final Assignment plan.
- 9.2. 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 (MSc. course) or Academic Board (PGD course) and the participant having received one written warning and being given time to improve performance.
- 9.3. 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 thesis, the Thesis Assessment Board will decide not to assess the thesis. Extensions of the thesis period are then not possible. This means that the MSc. degree cannot be awarded. The participant will get a Postgraduate diploma.

In case of plagiarism in the submitted final assignment of the Postgraduate diploma course, the Course Director may decide that the final assignment will not be assessed. This will mean that the Diploma cannot be awarded, the participant will get a Certificate.

- 9.4. In case of other types of misbehaviour, the Course Director will consider expulsion from the course.
- 9.5. 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.
- 9.6. 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.

10. Student appeal procedures

- 10.1. In case of problems of a general or structural nature in the course, the Student Association Board (SAB) may be consulted.
- 10.2. In the event that a participant disagrees with decisions taken by a staff member or Thesis Assessment Board, he/she may present this decision for reconsideration to the Course Director.
Where a participant finds that he/she is not receiving the quality of thesis / final assignment supervision required in the regulations, the participant should also seek action from the Course Director.
- Only in the event that a MSc. participant disagrees with decisions taken by the Degree Assessment Board he/she may present this decision for reconsideration to Head Education directly (see rule 10.3).
- 10.3. 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.
- 10.4. 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 10.2 and 10.3) have not led to agreement;
 - The appeal concerns the implementation of these 'ITC Regulations for Master of Science (MSc.) degree and Postgraduate diploma courses' or the assessment of the thesis / Final assignment and
 - The appeal has been made before the official end of the course. Appeals concerning the assessment of the thesis can be made later 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.
- 10.5. Where unequal treatment of participants is claimed, copies of all relevant scripts shall be made available for review by those investigating the appeal.
- 10.6. 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 thesis, staff members representing fields related to the subject of research will be invited to sit on the Student Appeals Board.
- 10.7. After having heard all parties involved (including the Course Director) for relevant information, the Student Appeals Board will take a final decision on the appeal,. 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.
- 10.8. The Student Appeals Board can reject the appeal or support it. In the latter case, the Student Appeals Board shall suggest remedial actions, which may include extension of the fellowship.

- 10.9. 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 thesis, the fellowship may only be extended when the appeal is made before the official end of the course.
- 10.10. Support to a request for reconsideration or appeal concerning the assessment of the thesis cannot lead to overruling the assessment of the thesis by a Thesis Assessment Board that is composed according to these regulations. Acceptable remedial actions do include a re-sit for the oral part of the thesis examination (only when a reason beyond the control of the participant has caused underperformance in the oral part) or an extension to the research period (only when the main cause of unsatisfactory level of the thesis has been beyond the control of the participant) in combination with a full re-examination.

Support to a request for reconsideration or appeal concerning the assessment of the final assignment in the Postgraduate diploma course cannot lead to overruling the assessment of the final assignment, carried by (a) supervisor(s) according to these regulations. Acceptable remedial actions do include a re-examination (only when a reason beyond the control of the participant has caused underperformance in the oral part) by the supervisor(s) or two other ITC staff members with sufficient expertise in the subject of the Final Assignment.

Appendix

Bodies and persons involved in management and quality assurance of the MSc. course and the Postgraduate diploma course

The mentioned tasks and responsibilities must be carried out in accordance with these 'ITC Regulations for the Master of Science (MSc.) degree and Postgraduate diploma 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, Director Graduate Programme and Student Appeals Board.

Scientific Council

The Scientific Council advises 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 and thesis examination criteria.
- Advice on ITC's quality assurance system
- Advice on degree and assessment regulations, including these 'ITC Regulations for the Master of Science (MSc.) degree and Postgraduate diploma 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 MSc. and Postgraduate diploma 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 of Science (MSc.) degree and Postgraduate diploma courses'
- Acting as Degree Assessment Board
- Decision on deviation of the formal curriculum by individual participants in the Postgraduate diploma course.
- Decision on award of the Diploma to individual participants in the Postgraduate diploma course.

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

Research theme leader

The Research Theme leader is responsible for all research carried out by the scientific staff and participants connected to that theme. This responsibility includes:

- Admission of the participant to the research theme
- Monitoring of the quality of the research supervision given to MSc. participants under the theme

Research theme leaders are ITC (associate) professors.

Head Education

Head Education is responsible for:

- Monitoring of the implementation of the MSc. course and Postgraduate diploma 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. Head Education delegates the coordination of supra-course aspects of block 3 and block 4 of all MSc. courses to the Director Graduate Programme

Course Director (CD)

The Course Director is responsible for:

- Implementation of the MSc. course and Postgraduate diploma 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

Director Graduate Programme

The Director Graduate Programme is responsible for:

- Coordination of the development and implementation of supra-course aspects of block 3 (research orientation) and block 4 (individual research period) of the MSc. course

Degree Assessment Board

The Degree Assessment Board assures that participants who are awarded the MSc. degree have the required level.

This responsibility includes:

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

The Academic Board acts as Degree Assessment Board.

Thesis Admission Committee

The thesis Admission Committee is responsible for assessment of the thesis proposal and admission to the research part of the MSc. course.

Thesis Assessment Board

Responsible for assessment of the thesis and oral examination of the participant on completion of the research.

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.

EA/4334

**Additional rules for
short courses and individual study programmes leading to an
ITC CERTIFICATE¹
- September 2009 -**

Short courses and individual study programmes consist of modules of an ITC (Postgraduate) Diploma, Master and/or Master of Science (MSc.) course. The regulations that apply to the latter courses apply to the parts as well. Only the rules described below take precedence over the Diploma, Master and MSc. regulations.

1. These additional rules apply to all courses and individual study programmes leading to an ITC Certificate starting from September 2009 onwards². These courses consist of one or more modules of a Diploma, Master and/or Master of Science course.

Short courses have specific course objectives. These courses may start and/or finish with a few days for introductory respectively rounding-off activities. The individual study programmes consist of one or more separate modules chosen by the participant.

2. **Management of the course**
The curriculum of short courses has been approved by the Academic Board. Individually chosen combinations of separate modules need the approval of the Course Director. In case the individual study programme consists of modules of block 3 of the MSc. course only or of a combination of modules from more than one domain, approval of Head Education is needed.
Individual changes made in the course curriculum of the short course lead to the course being seen as an individual study programme.

Responsibility for implementation of the approved short course or individual study programme rests with Head Education, who delegates this responsibility to the Course Director(s) or, in the case of elective modules, to Module Coordinators.

Responsibility for quality assurance rests with the Academic Board.

3. **Assessment**
Courses leading to a Certificate are summatively assessed.
The right to re-sit for an examination exists only when the date of the re-sit falls within the official study period of the participant.

¹ *These rules were approved by the Rector and by the Academic Board on 17 September 2008; they apply to all courses commencing September 2009 onwards.*

² *Per 1 January 2010 ITC will be integrated in and will become a Faculty with special status of the University of Twente. This integration might have consequences for the assessment regulations and might lead to changes in these assessment regulations during the course.*

4. **Certification**

A "Certificate", mentioning that the participant has followed the course, will be awarded to a participant in a short course who has fulfilled all assessment requirements for that course. For short courses of 4 or more modules one module mark between 50 and 60 is allowed.

A "Certificate", mentioning that the participant 'has followed an individual study programme in Geo-information Science and Earth Observation', will be awarded to

- A participant in a short course who has fulfilled the assessment requirements of one module but has not fulfilled all assessment requirements of that short course and to
- A participant in an individual study programme who has fulfilled the assessment requirements of at least one module.

A "Certificate of Attendance", mentioning that the participant 'has attended an individual study programme in Geo-information Science and Earth Observation', will be awarded to all other participants who have participated for at least 80% in one or more modules. The titles of these modules will be mentioned on the Certificate of Attendance.

Certificates and Certificates of Attendance mention the study load. Only the study load of the modules that have been completed and the study load of the modules that the participant has participated in for at least 80%, are included in the study load.

Certificates are accompanied by a Course Record mentioning the period of study, the study load and the titles of the modules that the participant has completed or participated in for at least 80%.

Certificates, Certificates of Attendance and accompanying Course Records are signed by the Course Director or, in case the short course or individual study programme consists of modules 14 and 15 of the MSc. course only or of a combination of modules from more than one domain, by Head Education. Certificates and Certificates of Attendance of distance courses are signed by the Course Coordinator and by the Course Director or, in case of new distance courses, by Head Education.

5. **Building blocks for Diploma or Degree**

Successfully completed modules of short courses and individual study programmes can be used as building blocks for obtaining an ITC (Postgraduate) Diploma, Master degree or MSc. degree, provided the participant has been formally admitted to the (Postgraduate) Diploma, Master or Master of Science course.

Participants have three and a half years to meet all requirements of the (Postgraduate) Diploma, Master or MSc. course. 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 (MSc. and Master courses) or Academic Board (Diploma courses).

Appendix:

- ITC Regulations for courses leading to an ITC Master of Science (MSc.) degree or ITC Postgraduate diploma (September 2009),
- ITC Regulations for courses leading to an ITC Master degree (September 2009) or ITC Regulations for courses leading to an ITC Diploma (September 2009).