VU VRIJE UNIVERSITEIT AMSTERDAM Faculty of Science

Teaching and Examination Regulations

MASTER's Degree Programme

Computer Science (joint degree)

B. Programme-specific section

Academic year 2017-2018

Section B: Programme-specific section

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1.   General provisions

Article 1.1   Definitions
Not applicable

Article 1.2   Degree programme information
1.   The programme in Computer Science (CROHO number 65014) is a full-time programme taught in English.
2.   The programme consists of 120 credits.
3.   A unit of study comprises 6 EC or a multiple thereof.
4.   This programme is offered in partnership with the Universiteit van Amsterdam and leads to a joint degree.

Article 1.3   Intake dates
The programme is offered starting in the first semester of the academic year (1 September) and starting in the second semester (1 February). The intake date(s) mentioned in this paragraph ensure(s) that a programme can be completed within the nominal study duration set for the programme.

2.   Programme objectives and exit qualifications

Article 2.1   Programme objective
The programme aims to provide students with the knowledge, experience and insight they need to pursue a career as a computer science specialist or to engage in scientific research. Moreover, the programme seeks to provide students with a practical understanding of the field of Computer Science in a broad scientific, philosophical and social context.

The goal of the programme is to expand on the knowledge and skills acquired at Bachelor's level. By choosing a specialization, the student engages with the cutting-edge of scientific endeavour or of application and design.

Article 2.2   Exit qualifications
A graduate of the Master's programme in Computer Science:
- Possesses solid academic knowledge and insight in the field of computer science, including the required background knowledge from other academic disciplines, which builds upon and goes beyond the level of a Bachelor's degree;
- Has knowledge, insight and skills of a specialist nature in at least one area of computer science (additional final attainment levels to be given for each specialization separately);
- is able to acquire specialist knowledge, insights and skills in other areas of computer science within a reasonable period of time;
- has acquired practical skills in relevant sub-areas of the field of computer science at Master level;
- is aware of the applications of computer science in general and of the chosen specialization in particular, and is able to apply his/her knowledge and skills to new or otherwise unknown problems;
- is capable of designing a research or project plan on the basis of a realistic problem description in the field of computer science and can contribute to its progress with original solutions;
- able to carry out research independently, both individually and in small teams.
- is able to consult and use the international professional literature in the relevant sub-areas of the field of computer science;
- is able to formulate, analyse and evaluate scientific results, and to use them to draw conclusions;
- is able to function in professional situations where scientific knowledge and skills in computer science are required;
- has developed a critical, scientific attitude and is aware of the societal aspects and historical context of information technology;

- is able to communicate with others at a professional level and can give clear oral and written presentations of the results of his/her work;
- is thoroughly prepared for further education at doctorate level or for further postgraduate education as a professional computer scientist.

The Master's programme in Computer Science offers the following specializations:

BDE: Big Data Engineering
CSS: Computer Systems Security
FCC: Foundations of Computing and Concurrency
IWT: Internet and Web Technology
PCS: Parallel Computing Systems
SEG: Software Engineering and Green IT

Each of these specialisations has its own specific set of requirements, on top of the general requirements listed above.

Beyond the general requirements of a Computer Science Master, the graduate of *Big Data Engineering* is expected to have acquired knowledge, competences, and insight on

- BDE-1. Architecture and scalability of data processing platforms and their programming models.
- BDE-2. The world wide web as a global information source.
- BDE-3. Conducting experiments on data processing systems, and be able to properly interpret data that result from such experiments.

Beyond the general requirements of a Computer Science Master, the graduate of *Computer Systems Security* is expected to have acquired knowledge, competences, and insight on:

- CSS-1. Security issues in system-level software including weaknesses and defenses
- CSS-2. Static and dynamic analysis techniques for software (benign and malicious)
- CSS-3. Security implications of modern hardware features (side channels, hardware bugs, and hardware-based protection)

Beyond the general requirements of a Computer Science Master, the graduate of *Foundations of Computing and Concurrency* is expected to have acquired knowledge, competences, and insight on:

- FCC-1. Models of computation
- FCC-2. Models of concurrency
- FCC-3. Automated verification

Beyond the general requirements of a Computer Science Master, the graduate of *Internet and Web Technology* is expected to have acquired knowledge, competences, and insight on:

- IWT-1. Distributed computer systems, notably in the form of capabilities for designing networked systems and with emphasis on efficient information processing on the Internet
- IWT-2. Programming large and complex pieces of (possibly low-level) systems-oriented software
- IWT-3. Conducting experiments on networked applications and distributed systems, and be able to properly interpret data that result from such experiments.

Beyond the general requirements of a Computer Science Master, the graduate *Parallel Computing Systems* is expected to have acquired knowledge, competences, and insight on:

- PCS-1. Design and architecture of parallel and distributed computing systems
- PCS-2. Performance and efficiency of application programs and the related runtime systems and middleware services
- PCS-3. Conducting experiments as a means for the analysis of high-performance systems, and be able to properly interpret data that result from such experiments.

Beyond the general requirements of a Computer Science Master, the graduate of *Software Engineering and Green IT* is expected to have acquired knowledge, competences, and insight on:

- SEG-1. Reconciling conflicting software project objectives, finding acceptable compromises within limitations of cost, time, knowledge, existing systems, organisations, and societal aspects of software technology
- SEG-2. Understanding and applying current theories, models and techniques that provide a basis for decision making on IT investment issues, problem identification and analysis, software architecture, software design, development, implementation, testing, documentation and reengineering
- SEG-3. Designing and conducting experiments (and empirical studies in general) to analyse and assess the relation between software systems, energy efficiency and sustainability issues.

3.   Further admission requirements

Article 3.1   Admission requirements
1.   Students will be admitted to the degree programme if they hold a letter of acceptance, issued by or on behalf of the Faculty Board because they have demonstrated that they meet the knowledge, understanding and skills requirements reflecting the final level of attainment in an academic Bachelor's degree programme.
2.   The Examination Board will assess each individual application for admission with regard to the admission requirements.
3.   In addition to the requirements mentioned in the first paragraph, the Examination Board will also assess applications for admission based on the following criteria:
    a.   talent and motivation;
    b.   command of methods and techniques.
4.   Anyone with a Bachelor's degree in Computer Science from a Dutch university meets the requirements referred to in the first paragraph.
5.   If the Master's programme consists of various programmes, then a prerequisite may be set for each programme consisting of a completed Bachelor's specialization or minor.
6.   Those not yet in possession of a Bachelor's degree, but who meet the admission requirements as regards the knowledge, insight and skills specified in paragraph 1, may on request be granted conditional admission to the associated Master's programme, insofar as failure to grant admission would result in undue unfairness..

Article 3.2   Pre-Master's programme
1.   Applicants who have a Bachelor's degree in a field that sufficiently corresponds to the field of the Master's programme may request admission to the pre-Master's programme.
2.   A certificate stating that the student has successfully completed the pre-Master's programme serves as a letter of acceptance to the associated Master's programme in the next academic year.
3.   The letter of acceptance relates exclusively to the academic year following the academic year in which the application for the letter of acceptance was submitted, unless the Executive Board decides otherwise.

Article 3.3   Limited programme capacity
Not applicable

Article 3.4   Final deadline for registration
A candidate must submit a request to be admitted to the programme through Studielink before 1 June in the case of Dutch students, before 1 April in the case of EU students and before 1 February in the case of non-EU students. Under exceptional circumstances, the Examinations Board may consider a request submitted after this closing date.

Article 3.5   English language requirement for English-language Master's programmes
1.   The proficiency requirement in English as the language of instruction can be met by the successful completion of one of the following examinations or an equivalent:
    - IELTS: 6.5

- TOEFL paper based test: 580
- TOEFL internet based test: 92-93
- Cambridge Advanced English: A, B or C.

2. Exemption is granted from the examination in English referred to in the first paragraph to students who, within two years of the start of the programme:
   - met the requirements of the VU test in English language proficiency TOEFL ITP, with at least the scores specified in paragraph 1, or
   - had previous education in secondary or tertiary education in an English-speaking country as listed on the VU website, or
   - have an English-language 'international baccalaureate' diploma

Article 3.6   Free curriculum

1. Under certain conditions, students have the option of departing from the standard curriculum as prescribed by the programme Computer Science and composing their own study programme.
2. The composition of such a programme requires the prior approval of the Examination Board Computer Science that has the greatest jurisdiction over the programme components.
3. The free programme Computer Science is to be composed by the student from educational units offered by VU University Amsterdam, University of Amsterdam or another Dutch university, and is to comprise at least the same study load, depth and scope as a standard Master's programme.

4.   Curriculum structure

Article 4.1   Composition of programme

The programme has a study load of 120 credits and consists of the following components:
   a. Required educational units
   b. Practical components
   c. Optional subjects (electives)

Article 4.2   Compulsory units of study

The compulsory units of study are:

Big Data Engineering

Course Code	Course Name	EC	Period	Level
X_400108	Data Mining Techniques	6	5	500
X_400130	Distributed Systems	6	2	400
X_405111	Seminar	6	Ac. Year	400
X_405116	Large Scale Data Engineering	6	1	500
XM_40020	Web Data Processing Systems	6	2	400
XM_400442	Master Project Computer Science	36	Ac. Year	500
XMU_418110	Web Services and Cloud-based Systems	6	Ac. Year	400
XMU_418143	Information Visualization	6	4	0

Computer Systems Security

Course Code	Course Name	EC	Period	Level
X_400127	Computer and Network Security	6	1	500
X_400130	Distributed Systems	6	2	400
X_405100	Binary and Malware Analysis	6	5	500
X_405111	Seminar	6	Ac. Year	400
XM_40014	Kernel Programming	6	1	400
XM_40019	Secure Software	6	2	500
XM_400442	Master Project Computer Science	36	Ac. Year	500
XMU_40012	Cybercrime and Forensics	6	4	400

Foundations of Computing and Concurrency

Course Code	Course Name	EC	Period	Level
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400130	Distributed Systems	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_405048	Advanced Logic	6	4	500
X_405111	Seminar	6	Ac. Year	400
XM_400121	Term Rewriting Systems	6	5	400
XM_400442	Master Project Computer Science	36	Ac. Year	500

Internet and Web Technology

Course Code	Course Name	EC	Period	Level
X_400130	Distributed Systems	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_405061	Service Oriented Design	6	1	400
X_405082	Internet programming	6	1	400
X_405105	Performance of Networked Systems	6	4	400
X_405111	Seminar	6	Ac. Year	400
XM_400442	Master Project Computer Science	36	Ac. Year	500
XMU_418110	Web Services and Cloud-based Systems	6	5	400

Parallel Computing Systems

Course Code	Course Name	EC	Period	Level
X_400130	Distributed Systems	6	2	400
X_400162	Parallel Programming Practical	6	2+3	500
X_405111	Seminar	6	Ac. Year	400
XM_40017	Programming Large-scale Parallel Systems	6	1	400
XM_400442	Master Project Computer Science	36	Ac. Year	500
XMU_40015	Parallel System Architectures	6	1	400
XMU_40016	Performance Engineering	6	5	500
XMU_40018	Programming Multi-core and Many-core Sys.	6	4	400

Software Engineering and Green IT

Course Code	Course Name	EC	Period	Level
X_400130	Distributed Systems	6	2	400
X_400170	Software Architecture	6	2	400
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_405061	Service Oriented Design	6	1	400
X_405111	Seminar	6	Ac. Year	400
X_418158	Green Lab	6	1	400
XM_400442	Master Project Computer Science	36	Ac. Year	500

Article 4.3   Practical exercise

The practical exercises are listed in Article 4.2. Required educational units marked as practical exercise (prac).

Article 4.4   Electives

The student can take of the following electives:

Big Data Engineering

Constrained Choice Foundations of Computing & Concurrency (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400211	Distributed Algorithms	6	5	500
X_405048	Advanced Logic	6	4	500
XM_400121	Term Rewriting Systems	6	5	400

Constrained Choice Mathematics (6 EC required)

Course Code	Course Name	EC	Period	Level
X_405041	Coding and Cryptography	6	4	500
X_405078	Experimental Design and Data Analysis	6	4	400

Constrained choice Software Engineering (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400170	Software Architecture	6	2	400

X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_405061	Service Oriented Design	6	1	400

Societal Perspectives on CS (6 EC required)

Course Code	Course Name	EC	Period	Level
R_E.commerc	E-Commerce Law	6	5	500
X_405101	ICT4D	6	5	400
XMU_418107	History of digital cultures	6	3	400

Pre-approved Elective Courses BDE

Course Code	Course Name	EC	Period	Level
X_400108	Data Mining Techniques	6	5	500
X_400111	Evolutionary Computing	6	1	400
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400127	Computer and Network Security	6	1	500
X_400170	Software Architecture	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_400650	Business Process Analytics	6	4	400
X_405048	Advanced Logic	6	4	500
X_405061	Service Oriented Design	6	1	400
X_405065	Knowledge and Media	6	1	500
X_405074	Developing Services for the Cloud	6	3	400
X_405082	Internet programming	6	1	400
X_405086	The Social Web	6	4	400
X_405097	Serious Games	6	5	400
X_405099	Knowledge Engineering	6	2	400
X_405100	Binary and Malware Analysis	6	5	500
X_405101	ICT4D	6	5	400
X_405105	Performance of Networked Systems	6	4	400
X_405115	Business Process Management	6	1	400
X_405116	Large Scale Data Engineering	6	1	500
X_405129	Watson Innovation	6	2	400
X_418158	Green Lab	6	1	400
XM_40012	Machine Learning for the Quantified Self	6	6	400
XM_400121	Term Rewriting Systems	6	5	400
XM_40014	Kernel Programming	6	1	400
XM_40017	Programming Large-scale Parallel Systems	6	1	400
XM_40019	Secure Software	6	2	500
XM_40020	Web Data Processing Systems	6	2	400
XM_405080	Industrial Internship	6	Ac. Year	400
XMU_40013	High Performance Computing and Big Data	6	3	400
XMU_40015	Parallel System Architectures	6	1	400
XMU_40016	Performance Engineering	6	5	500
XMU_40018	Programming Multi-core and Many-core Sys.	6	4	400

XMU_418108	Lambda Calculus	6	2	0
XMU_418110	Web Services and Cloud-based Systems	6	5	400
XMU_418111	Introduction to Computational Science	6	1	400
XMU_418143	Information Visualization	6	4	0

Computer Systems Security

Constrained Choice Foundations of Computing & Concurrency (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400211	Distributed Algorithms	6	5	500
X_405048	Advanced Logic	6	4	500
XM_400121	Term Rewriting Systems	6	5	400

Constrained Choice Mathematics (6 EC required)

Course Code	Course Name	EC	Period	Level
X_405041	Coding and Cryptography	6	4	500
X_405078	Experimental Design and Data Analysis	6	4	400

Constrained choice Software Engineering (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400170	Software Architecture	6	2	400
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_405061	Service Oriented Design	6	1	400

Societal Perspectives on CS (6 EC required)

Course Code	Course Name	EC	Period	Level
R_E.commerc	E-Commerce Law	6	5	500
X_405101	ICT4D	6	5	400
XMU_418107	History of digital cultures	6	3	400

Pre-approved Elective Courses

Course Code	Course Name	EC	Period	Level
X_400108	Data Mining Techniques	6	5	500
X_400111	Evolutionary Computing	6	1	400
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400127	Computer and Network Security	6	1	500
X_400170	Software Architecture	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_400650	Business Process Analytics	6	4	400
X_405048	Advanced Logic	6	4	500
X_405061	Service Oriented Design	6	1	400
X_405065	Knowledge and Media	6	1	500

Course Code	Course Name	EC	Period	Level
X_405074	Developing Services for the Cloud	6	3	400
X_405082	Internet programming	6	1	400
X_405086	The Social Web	6	4	400
X_405097	Serious Games	6	5	400
X_405099	Knowledge Engineering	6	2	400
X_405100	Binary and Malware Analysis	6	5	500
X_405101	ICT4D	6	5	400
X_405105	Performance of Networked Systems	6	4	400
X_405115	Business Process Management	6	1	400
X_405116	Large Scale Data Engineering	6	1	500
X_405129	Watson Innovation	6	2	400
X_418158	Green Lab	6	1	400
XM_40012	Machine Learning for the Quantified Self	6	6	400
XM_400121	Term Rewriting Systems	6	5	400
XM_40014	Kernel Programming	6	1	400
XM_40017	Programming Large-scale Parallel Systems	6	1	400
XM_40019	Secure Software	6	2	500
XM_40020	Web Data Processing Systems	6	2	400
XM_405080	Industrial Internship	6	Ac. Year	400
XMU_40013	High Performance Computing and Big Data	6	3	400
XMU_40015	Parallel System Architectures	6	1	400
XMU_40016	Performance Engineering	6	5	500
XMU_40018	Programming Multi-core and Many-core Syg	6	4	400
XMU_418108	Lambda Calculus	6	2	0
XMU_418110	Web Services and Cloud-based Systems	6	5	400
XMU_418111	Introduction to Computational Science	6	1	400
XMU_418143	Information Visualization	6	4	0

Foundations of Computing and Concurrency

Constrained Choice Mathematics (6 EC required)

Course Code	Course Name	EC	Period	Level
X_405041	Coding and Cryptography	6	4	500
X_405078	Experimental Design and Data Analysis	6	4	400

Constrained Choice Programming (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400162	Parallel Programming Practical	6	2+3	500
X_405064	Concurrency and Multithreading	6	2	400
X_405082	Internet programming	6	1	400
X_405124	Software Testing Practical	6	6	400
XM_40011	Android Lab	6	5+6	400
XM_40014	Kernel Programming	6	1	400
XM_405088	Individual Systems Practical	6	Ac. Year	500
XMU_40018	Programming Multi-core and Many-core Syg	6	4	400

Constrained Choice SE (6 EC required)

Course Code	Course Name	EC	Period	Level

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X_400170	Software Architecture	6	2	400
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_405061	Service Oriented Design	6	1	400

Societal Perspectives on CS (6 EC required)

Course Code	Course Name	EC	Period	Level
R_E.commerc	E-Commerce Law	6	5	500
X_405101	ICT4D	6	5	400
XMU_418107	History of digital cultures	6	3	400

Pre-approved Elective Courses

Course Code	Course Name	EC	Period	Level
X_400108	Data Mining Techniques	6	5	500
X_400111	Evolutionary Computing	6	1	400
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400127	Computer and Network Security	6	1	500
X_400170	Software Architecture	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_400650	Business Process Analytics	6	4	400
X_405048	Advanced Logic	6	4	500
X_405061	Service Oriented Design	6	1	400
X_405065	Knowledge and Media	6	1	500
X_405074	Developing Services for the Cloud	6	3	400
X_405082	Internet programming	6	1	400
X_405086	The Social Web	6	4	400
X_405097	Serious Games	6	5	400
X_405099	Knowledge Engineering	6	2	400
X_405100	Binary and Malware Analysis	6	5	500
X_405101	ICT4D	6	5	400
X_405105	Performance of Networked Systems	6	4	400
X_405115	Business Process Management	6	1	400
X_405116	Large Scale Data Engineering	6	1	500
X_405129	Watson Innovation	6	2	400
X_418158	Green Lab	6	1	400
XM_40012	Machine Learning for the Quantified Self	6	6	400
XM_400121	Term Rewriting Systems	6	5	400
XM_40014	Kernel Programming	6	1	400
XM_40017	Programming Large-scale Parallel Systems	6	1	400
XM_40019	Secure Software	6	2	500
XM_40020	Web Data Processing Systems	6	2	400
XM_405080	Industrial Internship	6	Ac. Year	400
XMU_40013	High Performance Computing and Big Data	6	3	400
XMU_40015	Parallel System Architectures	6	1	400
XMU_40016	Performance Engineering	6	5	500

Course Code	Course Name	EC	Period	Level
XMU_40018	Programming Multi-core and Many-core Syg	6	4	400
XMU_418108	Lambda Calculus	6	2	0
XMU_418110	Web Services and Cloud-based Systems	6	5	400
XMU_418111	Introduction to Computational Science	6	1	400
XMU_418143	Information Visualization	6	4	0

Internet and Web Technology

Constrained Choice Mathematics (6 EC required)

Course Code	Course Name	EC	Period	Level
X_405041	Coding and Cryptography	6	4	500
X_405078	Experimental Design and Data Analysis	6	4	400

Societal Perspectives on CS (6 EC required)

Course Code	Course Name	EC	Period	Level
R_E.commerc	E-Commerce Law	6	5	500
X_405101	ICT4D	6	5	400
XMU_418107	History of digital cultures	6	3	400

Pre-approved Elective Courses

Course Code	Course Name	EC	Period	Level
X_400108	Data Mining Techniques	6	5	500
X_400111	Evolutionary Computing	6	1	400
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400127	Computer and Network Security	6	1	500
X_400170	Software Architecture	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_400650	Business Process Analytics	6	4	400
X_405048	Advanced Logic	6	4	500
X_405061	Service Oriented Design	6	1	400
X_405065	Knowledge and Media	6	1	500
X_405074	Developing Services for the Cloud	6	3	400
X_405082	Internet programming	6	1	400
X_405086	The Social Web	6	4	400
X_405097	Serious Games	6	5	400
X_405099	Knowledge Engineering	6	2	400
X_405100	Binary and Malware Analysis	6	5	500
X_405101	ICT4D	6	5	400
X_405105	Performance of Networked Systems	6	4	400
X_405115	Business Process Management	6	1	400
X_405116	Large Scale Data Engineering	6	1	500
X_405129	Watson Innovation	6	2	400
X_418158	Green Lab	6	1	400
XM_40012	Machine Learning for the Quantified Self	6	6	400
XM_400121	Term Rewriting Systems	6	5	400

XM_40014	Kernel Programming	6	1	400
XM_40017	Programming Large-scale Parallel Systems	6	1	400
XM_40019	Secure Software	6	2	500
XM_40020	Web Data Processing Systems	6	2	400
XM_405080	Industrial Internship	6	Ac. Year	400
XMU_40013	High Performance Computing and Big Data	6	3	400
XMU_40015	Parallel System Architectures	6	1	400
XMU_40016	Performance Engineering	6	5	500
XMU_40018	Programming Multi-core and Many-core Sys.	6	4	400
XMU_418108	Lambda Calculus	6	2	0
XMU_418110	Web Services and Cloud-based Systems	6	5	400
XMU_418111	Introduction to Computational Science	6	1	400
XMU_418143	Information Visualization	6	4	0

Parallel Computing Systems

Constrained Choice Foundations of Computing & Concurrency (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400211	Distributed Algorithms	6	5	500
X_405048	Advanced Logic	6	4	500
XM_400121	Term Rewriting Systems	6	5	400

Constrained Choice Mathematics (6 EC required)

Course Code	Course Name	EC	Period	Level
X_405041	Coding and Cryptography	6	4	500
X_405078	Experimental Design and Data Analysis	6	4	400

Constrained choice Software Engineering (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400170	Software Architecture	6	2	400
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_405061	Service Oriented Design	6	1	400

Societal Perspectives on CS (6 EC required)

Course Code	Course Name	EC	Period	Level
R_E.commerc	E-Commerce Law	6	5	500
X_405101	ICT4D	6	5	400
XMU_418107	History of digital cultures	6	3	400

Pre-approved Elective Courses

Course Code	Course Name	EC	Period	Level
X_400108	Data Mining Techniques	6	5	500
X_400111	Evolutionary Computing	6	1	400
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500

X_400127	Computer and Network Security	6	1	500
X_400170	Software Architecture	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_400650	Business Process Analytics	6	4	400
X_405048	Advanced Logic	6	4	500
X_405061	Service Oriented Design	6	1	400
X_405065	Knowledge and Media	6	1	500
X_405074	Developing Services for the Cloud	6	3	400
X_405082	Internet programming	6	1	400
X_405086	The Social Web	6	4	400
X_405097	Serious Games	6	5	400
X_405099	Knowledge Engineering	6	2	400
X_405100	Binary and Malware Analysis	6	5	500
X_405101	ICT4D	6	5	400
X_405105	Performance of Networked Systems	6	4	400
X_405115	Business Process Management	6	1	400
X_405116	Large Scale Data Engineering	6	1	500
X_405129	Watson Innovation	6	2	400
X_418158	Green Lab	6	1	400
XM_40012	Machine Learning for the Quantified Self	6	6	400
XM_400121	Term Rewriting Systems	6	5	400
XM_40014	Kernel Programming	6	1	400
XM_40017	Programming Large-scale Parallel Systems	6	1	400
XM_40019	Secure Software	6	2	500
XM_40020	Web Data Processing Systems	6	2	400
XM_405080	Industrial Internship	6	Ac. Year	400
XMU_40013	High Performance Computing and Big Data	6	3	400
XMU_40015	Parallel System Architectures	6	1	400
XMU_40016	Performance Engineering	6	5	500
XMU_40018	Programming Multi-core and Many-core Sys.	6	4	400
XMU_418108	Lambda Calculus	6	2	0
XMU_418110	Web Services and Cloud-based Systems	6	5	400
XMU_418111	Introduction to Computational Science	6	1	400
XMU_418143	Information Visualization	6	4	0

<u>Software Engineering and Green IT</u>

Constrained Choice Foundations of Computing & Concurrency (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400211	Distributed Algorithms	6	5	500
X_405048	Advanced Logic	6	4	500
XM_400121	Term Rewriting Systems	6	5	400

Constrained Choice Mathematics (6 EC required)

Course Code	Course Name	EC	Period	Level
X_405041	Coding and Cryptography	6	4	500
X_405078	Experimental Design and Data Analysis	6	4	400

Constrained Choice Programming (6 EC required)

Course Code	Course Name	EC	Period	Level
X_400162	Parallel Programming Practical	6	2+3	500
X_405064	Concurrency and Multithreading	6	2	400
X_405082	Internet programming	6	1	400
X_405124	Software Testing Practical	6	6	400
XM_40011	Android Lab	6	5+6	400
XM_40014	Kernel Programming	6	1	400
XM_405088	Individual Systems Practical	6	Ac. Year	500
XMU_40018	Programming Multi-core and Many-core Sys.	6	4	400

Societal Perspectives on CS (6 EC required)

Course Code	Course Name	EC	Period	Level
R_E.commerc	E-Commerce Law	6	5	500
X_405101	ICT4D	6	5	400
XMU_418107	History of digital cultures	6	3	400

Pre-approved Elective Courses

Course Code	Course Name	EC	Period	Level
X_400108	Data Mining Techniques	6	5	500
X_400111	Evolutionary Computing	6	1	400
X_400115	Logical Verification	6		500
X_400117	Protocol Validation	6	1	500
X_400127	Computer and Network Security	6	1	500
X_400170	Software Architecture	6	2	400
X_400211	Distributed Algorithms	6	5	500
X_400412	Software Asset Management	6	1	400
X_400439	Software Testing	6	5	400
X_400650	Business Process Analytics	6	4	400
X_405048	Advanced Logic	6	4	500
X_405061	Service Oriented Design	6	1	400
X_405065	Knowledge and Media	6	1	500
X_405074	Developing Services for the Cloud	6	3	400
X_405082	Internet programming	6	1	400
X_405086	The Social Web	6	4	400
X_405097	Serious Games	6	5	400
X_405099	Knowledge Engineering	6	2	400
X_405100	Binary and Malware Analysis	6	5	500
X_405101	ICT4D	6	5	400
X_405105	Performance of Networked Systems	6	4	400
X_405115	Business Process Management	6	1	400
X_405116	Large Scale Data Engineering	6	1	500
X_405129	Watson Innovation	6	2	400
X_418158	Green Lab	6	1	400

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XM_40012	Machine Learning for the Quantified Self	6	6	400
XM_400121	Term Rewriting Systems	6	5	400
XM_40014	Kernel Programming	6	1	400
XM_40017	Programming Large-scale Parallel Systems	6	1	400
XM_40019	Secure Software	6	2	500
XM_40020	Web Data Processing Systems	6	2	400
XM_405080	Industrial Internship	6	Ac. Year	400
XMU_40013	High Performance Computing and Big Data	6	3	400
XMU_40015	Parallel System Architectures	6	1	400
XMU_40016	Performance Engineering	6	5	500
XMU_40018	Programming Multi-core and Many-core Sys.	6	4	400
XMU_418108	Lambda Calculus	6	2	0
XMU_418110	Web Services and Cloud-based Systems	6	5	400
XMU_418111	Introduction to Computational Science	6	1	400
XMU_418143	Information Visualization	6	4	0

If the student wishes to take a different course than the units of study listed, advance permission must be obtained in writing from the Examinations Board.

Article 4.5   Sequence of examinations
The study guide details those examinations and/or practical exercises that may only be taken once the exams of other (prior) components have been passed.

Article 4.6   Participation in practical exercise and tutorials
1.   Students are expected to participate actively in all degree components for which they are registered.
2.   In addition to the general requirement regarding active participation, the study guide details additional requirements for each degree component, as well as component attendance requirements.
3.   At the start of each degree component, a specification will be made available which details:
   1.   The final attainment levels of the degree component;
   2.   The study guidelines for passing the degree component;
   3.   The way in which the final attainment levels are assessed;
   4.   The regulations for examinations and resits;
   5.   The guidance provided by lecturers during scheduled hours and otherwise;
   6.   Component attendance requirements;
   7.   The provision of feedback to the student on assignments and reports submitted, and presentations given during the degree component.
4.   If a student is prevented by force majeure from attending a required degree component, then the student must send written notification of his or her absence to the examiner and the master coordinator as soon as possible. The examiner may, after consultation with the master coordinator, give the student an alternative assignment.
5.   Absence from degree components with required attendance is only allowed in the case of force majeure.
6.   In the event of inadequate participation, either qualitative or quantitative, the examiner may exclude the student from further participation in the degree component or a part of the degree component. The details of the student's inadequate participation must be recorded in advance and approved by Programme Director.
7.   Notwithstanding the provisions of Article 4.5 of Part A of the Academic and Examination Regulations, there is no resit for a computer practical.

Article 4.7   Maximum exemption
A maximum of 84 EC of the curriculum can be accumulated through granted exemptions.

Article 4.8   Validity period for results
No further specific provisions to article 4.8 of TER part A.

Article 4.9   Degree
Students who have successfully completed their Master's final examination are awarded a Master of Science degree. The degree awarded is stated on the diploma. If it is a joint degree, this will also be stated on the diploma.

5.   Transitional and final provisions

Article 5.1   Amendments and periodic review
1. Any amendment to the Teaching and Examination Regulations will be adopted by the faculty board after taking advice, and if necessary approval by the Programme Committee concerned. A copy of the advice will be sent to the authorized representative advisory body.
2. An amendment to the Teaching and Examination Regulations requires the approval of the authorized representative advisory body if it concerns components not related to the subjects of Section 7.13, paragraph 2 sub a to g and v of the WHW and the requirements for admission to the Master's programme.
3. An amendment to the Teaching and Examination Regulations can only pertain to an academic year that is already in progress if this does not demonstrably damage the interests of students.

Article 5.2   Transitional provisions
Notwithstanding the current Teaching and Examination Regulations, the following transitional provisions apply for students who started the programme under a previous set of Teaching and Examination Regulations:

Article 5.3   Publication
1. The faculty board will ensure the appropriate publication of these Regulations and any amendments to them.
2. The Teaching and Examination Regulations will be posted on VUnet.

Article 5.4   Effective date
These Regulations enter into force with effect from 1 September 2017.

Advice from Programme Committee, on 20 April 2017.

Advice from Examination Board of the Faculty of Science, on 10 November 2016

Approved by authorized representative advisory body, on 6 July 2017

Adopted by the Board of the Faculty of Science, on 21 July 2017.

Appendix I

List of articles that must be included in the OER pursuant to the WHW (articles in framed boxes):

Section A
Art. 1.1	7.13, para 1, WHW
Art. 2.1	7.13, para 2 sub w
Art. 3.2	7.13, para 2 sub e
Art. 4.2	7.13, para 2 sub h and l
Art. 4.3	7.13, para 2 sub n
Art. 4.4	7.13, para 2 sub o
Art. 4.5	7.13, para 2 sub j, h
Art. 4.7	7.13, para 2 sub r
Art. 4.8	7.13, para 2 sub k
Art. 4.9	7.13, para 2 sub p
Art. 4.10	7.13, para 2 sub q
Art. 4.11	7.13, para 2 sub a
Art. 5.1	7.13, para 2 sub u
Art. 5.2	7.13, para 2 sub m

Section B
Art. 1.2	7.13, para 2 sub i
Art. 2.1	7.13, para 1 sub b, c
Art. 2.2	7.13, para 2 sub c
Art. 3.1	7.25, para 4
Art. 4.1	7.13, para 2 sub a
Art. 4.2	7.13, para 2 sub e, h, j, l
Art. 4.3	7.13, para 2 sub t
Art. 4.4	7.13, para 2 sub e, h, j, l
Art. 4.5	7.13, para 2 sub s
Art. 4.6	7.13, para 2 sub d
Art. 4.8	7.13, para 2 sub k