

Onderwijs- en examenregeling

Masteropleiding Computer Science (single degree)

Deel B:
Opleidingsspecifiek deel
Studiejaar 2016-2017

Teaching and Examination Regulations

Master's programme in Computer Science (single degree)

Part B:
Programme-specific section
Academic year 2016-2017

De Onderwijs- en examenregeling Masteropleiding Computer Science 2016/2017 is identiek aan de Onderwijs- en examenregeling Masteropleiding Computer Science 2015/2016 en is geldig voor de uitfaserende Master Computer Science (single degree) aan de Vrije Universiteit Amsterdam. Nieuwe studenten worden verwezen naar de Onderwijs- en examenregeling Masteropleiding Computer Science (joint degree) 2016/2017.

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Deel B: opleidingsspecifiek deel

1. Algemene bepalingen

Artikel 1.1 Gegevens opleiding

1. De opleiding Computer Science, CROHO nummer 60300 wordt in voltijdse vorm verzorgd, en in het Engels uitgevoerd.
2. De opleiding heeft een omvang van 120 EC.
3. Een onderwijsseenheid omvat 6 EC of een veelvoud daarvan.
4. Binnen de opleiding kan de student kiezen uit de volgende specialisaties
 - a. CSS: Computer Systems and Security
 - b. FCC: Foundations of Computing and Concurrency
 - c. HPC: High-Performance Computing
 - d. IWT: Internet and Web Technology
 - e. SEG: Software Engineering and Green IT
 - f. TAI: Technical Artificial Intelligence

Artikel 1.2 Instroommoment

De opleiding wordt aangeboden met ingang van het eerste semester van een studiejaar (1 september) en met ingang van het tweede semester (1 februari). Voor elk van deze instroommomenten geldt dat er sprake is van een studeerbaar onderwijsprogramma dat in de nominale duur volledig afgerond kan worden.

2. Doelstellingen en eindtermen van de opleiding.

Artikel 2.1 Doelstelling opleiding

Het master programma Computer Science is een wetenschappelijke opleiding die er naar streeft de student kennis, ervaring en inzicht te verschaffen die nodig zijn voor zelfstandige (academische) beroepsuitoefening als informaticus. Het programma bereidt zowel voor op een verdere opleiding als wetenschappelijk onderzoeker als op een carrière in het bedrijfsleven. Bovendien tracht de opleiding de student een praktisch begrip te verschaffen van het gebied van de Informatica in een brede wetenschappelijke, wijsgerige en maatschappelijke context.

Het doel van het programma is het uitbreiden en verdiepen van de kennis en vaardigheden van het niveau van de Bachelor of Science en, door concentratie op een specialistisch gebied, de student naar het front van de wetenschap of van toepassingen en ontwerp te brengen.

Artikel 2.2 Eindtermen

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

Part B: Programme-specific section

1. General provisions

Article 1.1 Programme details

1. The programme in Computer Science (CROHO number 60300) is a full-time programme taught in English.
2. The programme consists of 120 credits.
3. An educational unit comprises 6 credits or a multiple thereof.
4. Students on the programme can choose from the following specializations:
 - a. CSS: Computer Systems and Security
 - b. FCC: Foundations of Computing and Concurrency
 - c. HPC: High-Performance Computing
 - d. IWT: Internet and Web Technology
 - e. SEG: Software Engineering and Green IT
 - f. TAI: Technical Artificial Intelligence

Article 1.2 Start date

The programme starts in the first semester of the academic year (1 September) and starting in the second semester (1 February). Students who start the programme one of these dates will normally be able to complete the full course of studies within the set time frame and graduate on time.

2. Programme objectives and exit qualifications

Article 2.1 Programme objectives

The Master's programme in Computer Science is an academic course of study that 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 requirements

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 university 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:

CSS: Computer Systems and Security

FCC: Foundations of Computing and Concurrency

HPC: High-Performance Computing

IWT: Internet and Web Technology

SEG: Software Engineering and Green IT

TAI: Technical Artificial Intelligence

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 *Computer Systems and 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. Modern scalable computer and network architecture
- CSS-4. Software development for modern, highly parallel computer systems

Beyond the general requirements of a Computer Science Master, the graduate of *Foundations of Computing and*

reasonable period of time;

- has acquired practical skills in relevant sub-areas of the field of computer science at university 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;
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- 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:

CSS: Computer Systems and Security

FCC: Foundations of Computing and Concurrency

HPC: High-Performance Computing

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- CSS-2. Static and dynamic analysis techniques for software (benign and malicious)
- CSS-3. Modern scalable computer and network architecture
- CSS-4. Software development for modern, highly parallel computer systems

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 *High-Performance Computing* is expected to have acquired knowledge, competences, and insight on:

- HPC-1. Parallel and distributed computing systems and their relationship with computational science
- HPC-2. Performance and efficiency of application programmes and the related runtime systems and middleware services
- HPC-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 *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 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.

Beyond the general requirements of a Computer Science Master, the graduate of *Technical Artificial Intelligence* is

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 *High-Performance Computing* is expected to have acquired knowledge, competences, and insight on:

- HPC-1. Parallel and distributed computing systems and their relationship with computational science
- HPC-2. Performance and efficiency of application programmes and the related runtime systems and middleware services
- HPC-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 *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 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.

Beyond the general requirements of a Computer Science Master, the graduate of *Technical Artificial Intelligence* is

expected to have acquired knowledge, competences, and insight on:

- TAI-1. Methods for designing AI systems, like knowledge-based systems and multi-agent systems
- TAI-2. Techniques for searching and optimisation, like evolutionary algorithms and neural networks
- TAI-3. The architecture and operation of AI systems.

3.Nadere toelatingseisen

Artikel 3.1 Toelatingseisen

1. Toelaatbaar tot de opleiding is de bezitter van een bewijs van toelating, verstrekt door of namens het faculteitsbestuur, omdat hij heeft aangetoond te voldoen aan de toelaatbaarheidseisen van kennis, inzicht en vaardigheden op het eindniveau van een wetenschappelijke bacheloropleiding.
2. Of een belangstellende voldoet aan de toelatingseisen wordt onderzocht door de Examencommissie.
3. Naast de vereisten, vermeld in het eerste lid beoordeelt de commissie de verzoeken tot toelating ook op de volgende criteria:
 - a. Talent en motivatie;
 - b. Beheersing van methoden en technieken
4. Aan de vereisten, bedoeld in het eerste lid, voldoet in ieder geval degene die een bachelorgraad in het wetenschappelijk onderwijs heeft behaald in de informatica aan een Nederlandse Universiteit.
5. Indien de masteropleiding verschillende programma's kent, kan voor de toelating tot elk van de programma's een met succes afgeronde afstudeerrichting of minor in de bacheloropleiding worden aangewezen.
6. Degene die nog niet in het bezit is van een bachelorgraad, maar wel voldoet aan de eisen van kennis, inzicht en vaardigheden, vermeld in lid 1, kan desgevraagd voorwaardelijk worden toegelaten tot de aansluitende masteropleiding, voor zo ver het achterwege laten van de inschrijving zou leiden tot een onbillijkheid van overwegende aard.

Artikel 3.2 Premasterprogramma

1. Degene die over een bachelorgraad beschikt in een vakgebied dat in voldoende mate overeenkomt met het vakgebied van de masteropleiding, kan toelating verzoeken tot de premasteropleiding.
2. Een bewijs van een met goed gevolg afgeronde premasteropleiding geldt als bewijs van toelating tot de daarin vermelde masteropleiding in het aansluitende studiejaar.
3. Het bewijs van toelating heeft uitsluitend betrekking op het studiejaar dat gelegen is na het studiejaar, waarin de aanvraag voor dat bewijs is ingediend, tenzij het college van bestuur anders beslist.

Artikel 3.3 niet van toepassing (n.v.t.)

expected to have acquired knowledge, competences, and insight on:

- TAI-1. Methods for designing AI systems, like knowledge-based systems and multi-agent systems
- TAI-2. Techniques for searching and optimisation, like evolutionary algorithms and neural networks
- TAI-3. The architecture and operation of AI systems.

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 not applicable

Artikel 3.4 Uiterste termijn aanmelding

1. Aanmelding, via Studielink, voor een masteropleiding door een student die geen bachelorexamen heeft behaald aan de VU is alleen mogelijk tot en met 31 mei 2016.
2. In afwijking van lid 1 dienen studenten die gebruik wensen te maken van diensten van het International Office op het gebied van visumbemiddeling en huisvesting zich voor 1 april 2016 aan te melden.
3. Inschrijven voor een masteropleiding is mogelijk tot en met 31 augustus 2016.
4. Een student die aan de VU een bacheloropleiding heeft gevolgd en een masteropleiding wil volgen, kan zich aanmelden en inschrijven tot en met 31 augustus 2016.

Artikel 3.5 Taaleisen Engels bij Engelstalige masteropleidingen

1. Aan de eis inzake beheersing van de instructietaal Engels, is voldaan na het met goed gevolg afleggen van één van de volgende examens of een equivalent daarvan:
 - IELTS: 6.5
 - TOEFL paper based test: 580
 - TOEFL internet based test: 92-93
 - Cambridge Advanced English: A, B of C.
2. Vrijstelling van het een in het eerste lid genoemd examen Engels wordt verleend aan degene die vwo eindexamen Engels heeft behaald of degene die niet langer dan twee jaar voor aanvang van de opleiding:
 - heeft voldaan aan de eisen van de VU-test Engelse Taalvaardigheid TOEFL ITP, minimaal met de scores zoals bepaald in het eerste lid, of
 - een vooropleiding secundair of tertiair onderwijs heeft genoten in een Engelstalig land dat als zodanig is vermeld op de website van de VU, of
 - die over een diploma 'international baccalaureate' (Engelstalig) beschikt

Artikel 3.6 Vrij programma

1. De student heeft de mogelijkheid om, onder bepaalde voorwaarden, een eigen onderwijsprogramma samen te stellen dat afwijkt van de door de opleiding Computer Science voorgeschreven onderwijsprogramma's.
2. De samenstelling van een dergelijk programma behoeft de voorafgaande goedkeuring van de examencommissie Computer Science die daarvoor het meest in aanmerking komt.
3. Het vrije programma Computer Science wordt door de student samengesteld uit de onderwijseenheden die door de Vrije Universiteit, de Universiteit van Amsterdam, of een andere Nederlandse universiteit worden aangeboden en heeft ten minste de omvang, breedte en diepgang van een reguliere masteropleiding.

Article 3.4 Registration deadline

1. Students who wish to apply for a Master's programme and have not obtained their Bachelor's degree at VU University Amsterdam must apply through Studielink by 31 May 2016.
2. As an exception to paragraph 1, students who wish to use the services of the International Office for assistance in securing visas and housing need to apply before 1 April 2016.
3. Registration for a Master's programme is only possible until 31 August 2016.
4. Students who have obtained their Bachelor's degree from VU University Amsterdam and wish to register for a Master's programme can apply and register until 31 August 2016.

Article 3.5 English language requirements for Master's programmes taught in English

1. Successful completion of one of the following examinations or an equivalent is regarded as proof that the requirement relating to proficiency in English as the language of instruction has been met:
 - IELTS: 6.5
 - TOEFL paper-based test: 580
 - TOEFL internet-based test: 92-93
 - Cambridge Advanced English: A, B or C.
2. An exemption from the English language proficiency requirement in paragraph 1 will be granted to those who have passed the final Dutch secondary school examination in English at pre-university level (VWO) and those who, no more than two years prior to commencement of the programme:
 - have met the requirements of the VU University Amsterdam English language proficiency test, TOEFL ITP, attaining or surpassing the score stated in paragraph 1, or
 - have completed secondary or higher education in an English-speaking country as specified on the relevant pages of VU University Amsterdam's website, or
 - have an international baccalaureate diploma (English taught).

Article 3.6 Free programme

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.Opbouw van het curriculum

Artikel 4.1 Samenstelling opleiding

De opleiding heeft een studielast van 120 EC en omvat de volgende onderdelen:

- Verplichte onderwijseenheden
- Praktische oefeningen
- Keuzeruimte

4.Structure of the curriculum

Article 4.1 Programme composition

The programme has a study load of 120 credits and consists of the following components:

- Required educational units
- Practical components
- Optional subjects (electives)

Artikel 4.2 Verplichte onderwijseenheden

MSc Computer Science

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
History of Digital Cultures	X_418107	6	3	-	-	400
Literature Study and Seminar	X_405111	6	Ac. year	-	v, pres	500
Master Project Computer Science	X_400442	36	Ac. year	pro	v, pres, o	400

Article 4.2 Required educational units

MSc Computer Science, Research specialisation Computer Systems and Security

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Advances in Computer Architecture	X_418047	6	1	-	-	500
Binary and Malware Analysis	X_405100	6	1	h, pra	-	600
Distributed Systems Programming Concurrent Systems	X_400130	6	2	h	t	400
Systems Security	X_418109	6	2	-	-	-
Advanced Topics in Computer Networks	X_405108	6	4	h	t, o	500
	X_418112	6	5	-	-	-

MSc Computer Science, Research specialisation Foundations of Computing and Concurrency

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Distributed Algorithms	X_400211	6	2	h, w	t	500
Advanced Logic	X_405048	6	4	h, w	t, o	500

MSc Computer Science, Research specialisation High-Performance Computing

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Advances in Computer Architecture	X_418047	6	1	-	-	500
Parallel Programming for High-Performance Applications	X_400161	6	1	h, pra	t	400
Distributed Systems Parallel Programming	X_400130	6	2	h	t	400
Practical Performance of Networked Systems	X_400162	6	2	pra	o	500
Large-scale Computing Infrastructures	X_405105	6	4	h	t, o	-
	X_405106	6	5	h	pres, o	500

MSc Computer Science, Research specialisation Internet and Web Technology

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Internet programming	X_405082	6	1	h	t, o	500
Service Oriented Design	X_405061	6	1	h	v	400
Distributed Algorithms	X_400211	6	2	h, w	t	500
Distributed Systems	X_400130	6	2	h	t	400
Performance of Networked Systems	X_405105	6	4	h	t, o	-
Web Services & Cloud Computing	X_418110	6	5	h, w	v, pres	-

MSc Computer Science, Research specialisation Software Engineering and Green IT

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Green Lab	X_418158	6	1	h, pra	o	400
Service Oriented Design	X_405061	6	1	h, w	v	400
Software Asset Management	X_400412	6	1	h	v	500
Distributed Systems	X_400130	6	2	h	t	400
Software Architecture	X_400170	6	2	h	-	400
Software Metrics	X_405121	6	4	-	-	500
Software Testing	X_400439	6	5	h	t, o	400

MSc Computer Science, Research specialisation Technical Artificial Intelligence

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Evolutionary Computing	X_400111	6	1	h	t, o	400
Model-based Intelligent Environments	X_405056	6	1	h, pro	o	500
Neural Networks	X_400132	6	1	h	t, o	500
Distributed Systems	X_400130	6	2	h	t	400
Knowledge Engineering	X_405099	6	2,3	h	v, o	400
Intelligent Web Applications	X_405055	6	4	h	v, o	400

Artikel 4.3 Praktische oefening

De praktische oefeningen zijn weergegeven in Artikel 4.2. Verplichte onderwijseenheden met de aanduiding werkvorm praktische oefening (pra).

Artikel 4.4 Keuzeruimte

De student kan, zonder voorafgaande toestemming van de examencommissie, de volgende keuzevakken volgen:

MSc Computer Science (alle specialisaties)

Constrained choice Mathematics
(6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Coding and Cryptography	X_405041	6	1	h, w	t, o	500
Experimental Design and Data Analysis	X_405078	6	5	h	v, o	400

Article 4.3 Practical exercise

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

Article 4.4 Optional subjects (electives)

The student does not need the prior approval of the Examination Board to take the following optional subjects:

MSc Computer Science (all specialisations)

Constrained choice Mathematics
(6 credits required)

Constrained choice Foundations of Computing and Concurrency (6EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Concurrency and Multithreading	X_405064	6	1	h, w	t, o	400
Concurrency theory	X_418103	6	1	-	-	600
Distributed Algorithms	X_400211	6	2	h, w	t	500
Advanced Logic	X_405048	6	4	h, w	t, o	500
Logical Verification	X_400115	6	5	h, pra	t, o	500
Protocol Validation	X_400117	6	5	-	-	500

Constrained choice Programming (6EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Internet programming	X_405082	6	1	h	t, o	500
Parallel Programming Practical	X_400162	6	2	pra	o	500
Computer Networks Practical	X_405072	6	5,6	pra	o	500
Software Testing Practical	X_405124	6	6	pra	v, pres	400
Operating Systems Practical	X_405071	6	Ac. year	pra	o	500
Individual Systems Practical	X_405088	6	Ac. year	-	o	500

Constrained choice Software Engineering (6EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Service Oriented Design	X_405061	6	1	h	v	400
Software Asset Management	X_400412	6	1	h	v	500
Software Architecture	X_400170	6	2	h	-	400
Software Metrics	X_405121	6	4	-	-	500
Software Testing	X_400439	6	5	h	t, o	400

Constrained choice Programming (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Internet programming	X_405082	6	1	h	t, o	500
Programming Concurrent Systems	X_418109	6	2	-	-	-
Computer Networks Practical	X_405072	6	5,6	pra	o	500
Software Testing Practical	X_405124	6	6	pra	v, pres	400
Operating Systems Practical	X_405071	6	Ac. year	pra	o	500
Individual Systems Practical	X_405088	6	Ac. year	-	o	500

Constrained choice Concurrency (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Concurrency and Multithreading	X_405064	6	1	h, w	t, o	400
Concurrency theory	X_418103	6	1	-	-	600

Constrained choice Models of Computation
(6 EC vereist)

Educational component	Subject code	Number of credits
Lambda Calculus	X_418108	6
Term Rewriting Systems	X_400121	6

Constrained choice Models of Computation
(6 credits required)

Period or semester	Teaching method	Examination format	Level
2	-	-	-
2	h, w	t	600

Constrained choice Foundations of Computation
(6 EC vereist)

Educational component	Subject code	Number of credits
Recursion Theory	X_400534	6
Computational Complexity	X_417017	6

Constrained choice Foundations of Computation
(6 credits required)

Period or semester	Teaching method	Examination format	Level
1	-	-	-
1	-	-	-

Constrained choice Verification (6 EC vereist)

Educational component	Subject code	Number of credits
Logical Verification	X_400115	6
Protocol Validation	X_400117	6

Constrained choice Verification (6 credits required)

Period or semester	Teaching method	Examination format	Level
5	h, pra	t, o	500
5	-	-	500

Constrained choice Software Engineering
(6 EC vereist)

Educational component	Subject code	Number of credits
Service Oriented Design	X_405061	6
Software Asset Management	X_400412	6
Software Architectuur	X_400170	6
Software Metrics	X_405121	6
Software Testing	X_400439	6

Constrained choice Software Engineering
(6 credits required)

Period or semester	Teaching method	Examination format	Level
1	h	v	400
1	h	v	500
2	h	-	400
4	-	-	500
5	h	t, o	400

MSc Computer Science, Research specialisation High-Performance Computing

Constrained choice Foundations of Computing and Concurrency (6 EC vereist)

Educational component	Subject code	Number of credits
Concurrency and Multithreading	X_405064	6
Concurrency theory	X_418103	6
Recursion theory	X_400534	6
Distributed Algorithms	X_400211	6
Advanced Logic	X_405048	6
Logical Verification	X_400115	6
Protocol Validation	X_400117	6

Constrained choice Foundations of Computing and Concurrency (6 credits required)

Period or semester	Teaching method	Examination format	Level
1	h, w	t, o	400
1	-	-	600
1	-	-	-
2	h, w	t	500
4	h, w	t, o	500
5	h, pra	t, o	500
5	-	-	500

Constrained choice Programming (6 EC vereist)

Educational component	Subject code	Number of credits
Internet programming	X_405082	6
Programming Concurrent Systems	X_418109	6
Computer Networks Practical	X_405072	6
Software Testing Practical	X_405124	6

Constrained choice Programming (6 credits required)

Period or semester	Teaching method	Examination format	Level
1	h	t, o	500
2	-	-	-
5,6	pra	o	500
6	pra	v, pres	400

Operating Systems Practical	X_405071	6	Ac. year	pra	o	500
Individual Systems Practical	X_405088	6	Ac. year	-	o	500

Constrained choice Software Engineering (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Service Oriented Design	X_405061	6	1	h	v	400
Software Asset Management	X_400412	6	1	h	v	500
Software Architectuur	X_400170	6	2	h	-	400
Software Metrics	X_405121	6	4	-	-	500
Software Testing	X_400439	6	5	h	t, o	400

Constrained choice Software Engineering (6 credits required)

MSc Computer Science, Research specialisation Internet and Web Technology

Suggested elective courses Foundations of Computing and Concurrency

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Concurrency and Multithreading	X_405064	6	1	h, w	t, o	400
Concurrency theory	X_418103	6	1	-	-	600
Advanced Logic	X_405048	6	4	h, w	t, o	500
Logical Verification	X_400115	6	5	h, pra	t, o	500
Protocol Validation	X_400117	6	5	-	-	500

Suggested elective courses Foundations of Computing and Concurrency

Suggested elective courses Programming

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Programming Concurrent Systems	X_418109	6	2	-	-	-
Parallel Programming Practical	X_400162	6	2	pra	o	500
Computer Networks Practical	X_405072	6	5,6	pra	o	500
Software Testing Practical	X_405124	6	6	pra	v, pres	400
Operating Systems Practical	X_405071	6	Ac. year	pra	o	500
Individual Systems Practical	X_405088	6	Ac. year	-	o	500

Suggested elective courses Programming

Suggested elective courses Software Engineering

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Software Asset Management	X_400412	6	1	h	v	500
Software Architectuur	X_400170	6	2	h	-	400
Software Metrics	X_405121	6	4	-	-	500
Software Testing	X_400439	6	5	h	t, o	400

Suggested elective courses Software Engineering

MSc Computer Science, Research specialisation Software Engineering & Green IT

Constrained choice Foundations of Computing and Concurrency (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Concurrency and Multithreading	X_405064	6	1	h, w	t, o	400

Constrained choice Foundations of Computing and Concurrency (6 credits required)

Concurrency theory	X_418103	6	1	-	-	600
Distributed Algorithms	X_400211	6	2	h, w	t	500
Advanced Logic	X_405048	6	4	h, w	t, o	500
Logical Verification	X_400115	6	5	h, pra	t, o	500

Constrained choice Programming (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Internet programming	X_405082	6	1	h	t, o	500
Programming Concurrent Systems	X_418109	6	2	-	-	-
Computer Networks Practical	X_405072	6	5,6	pra	o	500
Software Testing Practical	X_405124	6	6	pra	v, pres	400
Operating Systems Practical	X_405071	6	Ac. year	pra	o	500
Individual Systems Practical	X_405088	6	Ac. year	-	o	500

MSc Computer Science, Research specialisation Technical Artificial Intelligence

Constrained choice Foundations of Computing and Concurrency (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Concurrency and Multithreading	X_405064	6	1	h, w	t, o	400
Concurrency theory	X_418103	6	1	-	-	600
Distributed Algorithms	X_400211	6	2	h, w	t	500
Advanced Logic	X_405048	6	4	h, w	t, o	500
Logical Verification	X_400115	6	5	h, pra	t, o	500

Constrained choice Foundations of Computing and Concurrency (6 credits required)

Constrained choice Software Engineering (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Service Oriented Design	X_405061	6	1	h	v	400
Software Asset Management	X_400412	6	1	h	v	500
Software Architectuur	X_400170	6	2	h	-	400
Software Metrics	X_405121	6	4	-	-	500
Software Testing	X_400439	6	5	h	t, o	400

Constrained choice Software Engineering (6 credits required)

Constrained choice Programming (6 EC vereist)

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Internet programming	X_405082	6	1	h	t, o	500
Programming Concurrent Systems	X_418109	6	2	-	-	-
Computer Networks Practical	X_405072	6	5,6	pra	o	500
Software Testing Practical	X_405124	6	6	pra	v, pres	400
Operating Systems Practical	X_405071	6	Ac. year	pra	o	500
Individual Systems Practical	X_405088	6	Ac. year	-	o	500

Constrained choice Programming (6 credits required)

MSc Computer Science (alle specialisaties)

Toegelaten keuzevakken

Educational component	Subject code	Number of credits	Period or semester	Teaching method	Examination format	Level
Advances in Computer Architecture	X_418047	6	1	-	-	500
Binary and Malware Analysis	X_405100	6	1	h, pra	-	600
Business Process Management	X_405115	6	1	h, w	t, o	400
Evolutionary Computing	X_400111	6	1	h	t, o	400
Green Lab	X_418158	6	1	h, w	o	400
Introduction to Computational Science	X_418111	6	1	-	-	-
Knowledge and Media	X_405065	6	1	w	v	400
Neural Networks	X_400132	6	1	h	t, o	500
Parallel Programming for High-Performance Applications	X_400161	6	1	h, pra	t	400
Advanced Selforganisation	X_400434	6	2	h	v	400
Lambda Calculus	X_418108	6	2	-	-	-
Knowledge Engineering	X_405099	6	2,3	h	v, o	400
Developing Services for the Cloud	X_405074	6	3	h, w, pra	pres	500
Intelligent Web Applications	X_405055	6	4	h	v, o	400
Large Scale Data Engineering	X_405116	6	4	-	-	500
Performance of Networked Systems	X_405105	6	4	h	t, o	-
Systems Security	X_405108	6	4	h	t, o	500
The Social Web	X_405086	6	4	h	v, o	400
Advanced Topics in Computer Networks	X_418112	6	5	-	-	-
Data Mining Techniques	X_400108	6	5	h	o	500
ICT4D: Information and communication technology for Development	X_405101	6	5	h, pro	-	400
Large-scale Computing Infrastructures	X_405106	6	5	h	pres, o	500
Operating Systems	X_405067	6	5	h	t	400
Serious Games	X_405097	6	5	h, pra	v, o	400
Industrial Internship	X_405080	6	Ac. year	pro	v	500

De student die een ander vak wil volgen, dan de genoemde onderwijseenheden, dient vooraf schriftelijk toestemming van de examencommissie verkregen te hebben.

Artikel 4.5 Volgordelijkheid tentamens

Eventuele tentamens en/of praktische oefeningen waaraan niet eerder kan worden deelgenomen dan nadat het tentamen of de tentamens van andere (eerdere) onderdelen is/zijn behaald worden vernoemd in de studieids.

MSc Computer Science (all specialisations)

Pre-approved electives

Period or semester	Teaching method	Examination format	Level
1	-	-	500
1	h, pra	-	600
1	h, w	t, o	400
1	h	t, o	400
1	h, w	o	400
1	-	-	-
1	w	v	400
1	h	t, o	500
1	h, pra	t	400
2	h	v	400
2	-	-	-
2,3	h	v, o	400
3	h, w, pra	pres	500
4	h	v, o	400
4	-	-	500
4	h	t, o	-
4	h	t, o	500
4	h	v, o	400
5	-	-	-
5	h	o	500
5	h, pro	-	400
5	h	pres, o	500
5	h	t	400
5	h, pra	v, o	400
Ac. year	pro	v	500

The student who wishes to take a course other than those listed must first obtain prior written permission from the Examination Board.

Article 4.5 Sequence of exams

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.

Artikel 4.6 Deelname aan praktische oefening en werkgroepbijeenkomsten

1. Van elke student wordt actieve deelname verwacht aan het examenonderdeel waarvoor hij staat ingeschreven.
2. Naast de algemene eis dat de student actief participeert in het onderwijs, worden de aanvullende eisen per examenonderdeel in de studiegids omschreven. Hier staat ook omschreven voor welke onderdelen van het examenonderdeel een aanwezigheidsplicht geldt.
3. Bij het begin van een examenonderdeel is een beschrijving beschikbaar waarin een beschrijving staat van:
 1. De eindtermen van het examenonderdeel;
 2. De studierichtlijnen voor het behalen van een positief resultaat;
 3. De manier waarop de eindtermen worden getoetst;
 4. De tentamenregeling en herkansingsregeling;
 5. De begeleiding door de docent(en) binnen en buiten de geroosterde uren;
 6. De onderdelen van het examenonderdeel voor welke een aanwezigheidsplicht geldt;
 7. De manier waarop de student feedback krijgt op ingeleverde opdrachten, verslagen en presentaties tijdens het examenonderdeel.
4. Als een student door overmacht niet aanwezig kan zijn bij een verplicht onderdeel van het examenonderdeel, dient hij dit zo snel mogelijk schriftelijk te melden bij de examinerator en de mastercoördinator. De examinerator kan, na overleg met de mastercoördinator, besluiten om de student een vervangende opdracht op te leggen.
5. Het is niet toegestaan om verplichte onderdelen van een examenonderdeel te missen als er geen sprake is van overmacht.
6. Bij kwalitatief of kwantitatief onvoldoende deelname kan, welke van te voren is vastgelegd en is goedgekeurd door de opleidingsdirecteur, de examinerator de student uitsluiten van verdere deelname aan het examenonderdeel of een gedeelte daarvan.
7. In afwijking van het gestelde in OER deel A Artikel 4.5 kent een computerpracticum geen herkansing.

Artikel 4.7 Maximale vrijstelling

Maximaal 90 studiepunten van het onderwijsprogramma kunnen worden behaald op basis van verleende vrijstellingen.

Artikel 4.8 Geldigheidsduur resultaten

De geldigheidsduur van tentamens en vrijstellingen voor tentamens is conform Artikel 4.8 OER deel A.

Article 4.6 Participation in practical exercises and working group meetings

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

Up to 90 credits of the degree curriculum may be awarded on the basis of exemptions.

Article 4.8 Period of validity for results

The period of validity for examinations and exemptions for exams is in accordance with Article 4.8 of Part A of the Academic and Examination Regulations.

Artikel 4.9 Graad

Aan de student die het masterexamen met goed gevolg heeft afgelegd, wordt de graad Master of Science verleend. De verleende graad wordt op het getuigschrift vermeld. Ingeval het een gezamenlijke opleiding ('joint degree') betreft, wordt dat vermeld op het getuigschrift.

5.Overgangs- en slotbepalingen

Artikel 5.1 Wijziging en periodieke beoordeling deel B

1. Een wijziging van de onderwijs- en examenregeling van deel B wordt door het faculteitsbestuur vastgesteld na advies van de desbetreffende opleidingscommissie. Het advies wordt in afschrift verzonden aan het bevoegde medezeggenschapsorgaan.
2. Een wijziging van de onderwijs- en examenregeling behoeft de instemming van het bevoegde medezeggenschapsorgaan op de onderdelen die niet de onderwerpen van artikel 7.13, tweede lid onder a t/m g en v, alsmede het vierde lid WHW betreffen en de toelatingseisen tot de masteropleiding.
3. Een wijziging van de onderwijs- en examenregeling kan slechts betrekking hebben op een lopend studiejaar, indien de belangen van de studenten daardoor niet aantoonbaar worden geschaad.

Artikel 5.2 Overgangsbepalingen

In afwijking van de vigerende onderwijs- en examenregeling gelden voor de studenten die met de opleiding zijn begonnen onder een eerdere onderwijs- en examenregeling de volgende overgangsbepalingen:

n.v.t.

Artikel 5.3 Bekendmaking

1. Het faculteitsbestuur draagt zorg voor een passende bekendmaking van deze regeling, alsmede van elke wijziging daarvan.
2. De onderwijs- en examenregeling wordt geplaatst op de website van de faculteit en wordt geacht te zijn opgenomen in de studiegids.

Artikel 5.4 Inwerkingtreding

Deel B van deze regeling treedt in werking met ingang van 1 september 2016.

Advies opleidingscommissies, 23 juni 2015

Instemming bevoegd medezeggenschapsorgaan, d.d. 15 juli 2015 (FSr)

Vastgesteld door het bestuur van de Faculteit der Exacte Wetenschappen op 14 juli 2016.

Article 4.9 Degree

Students who fulfil all the requirements of the final Master's degree assessment will be awarded the degree of Master of Science. Details of the degree awarded will be recorded on the degree certificate. If the student is studying for a joint degree, then this will be mentioned on the degree certificate.

5.Transitional and final provisions

Article 5.1 Amendments and periodic assessment of Part B

1. An amendment to Part B of the Academic and Examination Regulations will be adopted by the Faculty Board on the recommendation of the relevant Programme Committee. A copy of this recommendation will be sent to the faculty's consultation body.
2. An amendment to the Academic and Examination Regulations requires the endorsement of the faculty's competent consultation body for those sections which do not relate to the subjects of Article 7.13 paragraphs 2 a to g and v, and paragraph 4 of the Act and the admission requirements for the Master's programme.
3. An amendment to the Academic and Examination Regulations may only relate to an academic year already in progress if the interests of the students are not demonstrably harmed.

Article 5.2 Transitional provisions

Notwithstanding the current Academic and Examination Regulations, the following transitional provisions apply to students who started on the programme when an earlier version of the Academic and Examination Regulations was in force:

n.a.

Article 5.3 Publication

1. The Faculty Board will ensure that these regulations are properly published, and that notice is given of each amendment.
2. The Academic and Examination Regulations will be published on the faculty's website and shall be included in the study guide.

Article 5.4 Entry into force

These regulations take effect on 1 september 2016.

Recommendations of the Programme Committees, 23 June 2015

Consent granted by the consultation bodies FSr (15 July 2015)

Adopted by the Board of the Faculty of Sciences on 14 July 2016.

Bijlage I

Overzicht artikelen waarvan in de WHW is bepaald dat deze in de OER moeten worden opgenomen (omkaderde artikelen):

Deel A

art. 1.17.13 lid 1 WHW
art. 2.17.13 lid 2 sub w
art. 3.27.13 lid 2 sub e
art. 4.27.13 lid 2 sub h en l
art. 4.37.13 lid 2 sub n
art. 4.47.13 lid 2 sub o
art. 4.57.13 lid 2 sub j, h
art. 4.77.13 lid 2 sub r
art. 4.87.13 lid 2 sub k
art. 4.97.13 lid 2 sub p
art. 4.107.13 lid 2 sub q
art. 4.117.13 lid 2 sub a
art. 5.17.13 lid 2 sub u
art. 5.27.13 lid 2 sub m

Deel B

art. 1.27.13 lid 2 sub i
art. 2.17.13 lid 1 sub b, c
art. 2.27.13 lid 2 sub c
art. 3.17.25 lid 4
art. 4.17.13 lid 2 sub a
art. 4.27.13 lid 2 sub e, h, j, l,
art. 4.37.13 lid 2 sub t
art. 4.47.13 lid 2 sub e, h, j, l,
art. 4.57.13 lid 2 sub s
art. 4.67.13 lid 2 sub d
art. 4.87.13 lid 2 sub k

Bijlage II

Appendix I

Summary of Articles which must be included in the Academic and Examination Regulations in accordance with the Act (articles in boxes):

Part A

Art. 1.17.13 paragraph 1 of the Act
Art. 2.17.13 paragraph 2 (w)
Art. 3.27.13 paragraph 2 (e)
Art. 4.27.13 paragraph 2 (h, l)
Art. 4.37.13 paragraph 2 (n)
Art. 4.47.13 paragraph 2 (o)
Art. 4.57.13 paragraph 2 (j, h)
Art. 4.77.13 paragraph 2 (r)
Art. 4.87.13 paragraph 2 (k)
Art. 4.97.13 paragraph 2 (p)
Art. 4.107.13 paragraph 2 (q)
Art. 4.117.13 paragraph 2 (a)
Art. 5.17.13 paragraph 2 (u)
Art. 5.27.13 paragraph 2 (m)

Part B

Art. 1.27.13 paragraph 2 (i)
Art. 2.17.13 paragraph 1 (b, c)
Art. 2.27.13 paragraph 2 (c)
Art. 3.17.25 paragraph 4
Art. 4.17.13 paragraph 2 (a)
Art. 4.27.13 paragraph 2 (e, h, j, l)
Art. 4.37.13 paragraph 2 (t)
Art. 4.47.13 paragraph 2 (e, h, j, l)
Art. 4.57.13 paragraph 2 (s)
Art. 4.67.13 paragraph 2 (d)
Art. 4.87.13 paragraph 2 (k)

Appendix II