



## Master of Applied Sciences and Engineering: Computer Science

The Master of Computer Science is a two-year (120 ECTS\* credits) advanced study in computer science organized by the Vrije Universiteit Brussel, a Flemish university located in Brussels, Belgium. This English-speaking programme is designed for students with a solid, basic academic background in computer science (Bachelor in Computer Science). The objectives of the programme are to provide a deeper understanding and knowledge of various specializations of computer science and to prepare the student for an active role in computer science research and development. The following specializations are offered:

- Artificial Intelligence
- Multimedia
- Software Engineering
- Web & Information Systems

### Programme strengths

The Faculty of Science and the Faculty of Engineering of the Vrije Universiteit Brussel have joined forces to offer a highly competitive and interesting programme. The courses and specializations are strongly embedded in the ongoing research activities of our research groups, each of which specialize in a particular domain of computer science. The research groups participate in various international research networks and projects. Master's students carry out their study in one of these groups. By being part of a professional research team, students receive maximal opportunities to learn and develop scientific skills and to participate in this world-class research. The teams also have experience in developing research trajectories that have societal and economic impact. They have implemented active policies on technology and knowledge transfer, patenting, spin-off creation, industrial networking and innovation.

Furthermore, courses are designed to promote an active style of learning. In addition to regular lectures, a broad range of instruction techniques are employed, such as group and individual projects, seminars, workshops, and research training courses. It is also possible to take courses from another Belgian university or to study for one or two semesters at a foreign university. The language of instruction is English.

### Programme outline

All students are required to complete a 30-credit core programme, a 6-credit research training course and a 24-credit master's thesis. Students choose one of four specializations: Artificial Intelligence, Multimedia, Software Engineering, or Web & Information Systems. The specialization part consists of at least 30 credits of core specialization courses and 30 credits optional courses. The total number of credits for this programme is 120 ECTS credits.

#### The specializations are:

**Artificial Intelligence:** The focus in this specialization is on building intelligent software artefacts. The theories of complex dynamic systems and self-organization are emphasized starting from the theory of complex dynamic systems as developed in related fields, such as mathematics, physics, and biology. Students will be exposed to current research in the areas of adaptive systems, multi-agent systems, and the origins of language.

**Multimedia:** Students in this specialization will conduct in-depth exploration of techniques for signal processing and communication of multimedia content. The program is designed to build thorough technological and scientific knowledge of various multimedia domains, such as digital television, telephony and videophony, computer animation, computer games, and the Internet. Students will gain experience with complex ICT architectures for the processing, distribution, and consumption of multimedia content.

**Software Engineering:** In this specialization, students gain the skills needed to build complex software applications and software-intensive systems. Students are also taught scientifically sound methods, as well as the newest techniques and tools for the development of software. The curriculum also includes research topics in programming languages and integrated development environments.

**Web & Information Systems:** This specialization is geared towards information-system development and application development in the context of the Web. Students will learn about data and semantic representation techniques and acquire thorough technological and scientific knowledge related to the newest technological developments for the Web. Students can participate in research in the area of ontologies, new media systems (multimedia, Virtual Reality, computer games, social systems, and the "Internet of Things").

The complete programme, the courses and their content can be found on the website of the university in the section for prospective students.

Compulsory	(60 ECTS*)**
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Philosophy of Sciences	3
Methods of Scientific Research	3
Theory of Computation and Information Theory	6
Declarative Programming	6
Software Architectures	6
Open Information Systems	6
Master thesis Computer Science	24
Research Training	6

Core Courses for each specialization (to select 30 ECTS)
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Artificial Intelligence
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Actual Trends in Artificial Intelligence	6
Adaptive Systems	6
Heuristic Optimisation	4
Language as a Complex Adaptive System	6
Mathematical Background for Complex Systems Science	6
Multi-agent Learning	6
Swarm Intelligence	4

Multimedia
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Capita Selecta Multimedia	3
Computer Graphics & Computer Vision	6
Digital Speech and Audio Processing	6
Image Processing	3
Image and Video Technology	5
Internet Protocols	6
Graphic Systems	6
Digital Video Broadcasting	3

Software Engineering
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Aspect Oriented Software Development	6
Capita Selecta of Software Engineering	6
Functional Programming	6
Principles of Object-oriented Programming Languages	6
Programming Languages	6
Programming Language Engineering	6
Software Distribution and Mobility Seminar	6

Web & Information Systems
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Advanced Databases	6
Internet Protocols	6
Seminar Web Information Systems Technology	6
User Interface Design	6
Web Engineering	6
Web Information Systems	6

Electives	ECTS
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Adaptive Systems Seminar	6
Advanced Computer Architecture	3
Auditing, Security, Privacy, and Ethical Problems	6
Bioinformatics	6
Biomedical Signals and Images	6
Business Models and Strategies in Networked Services	6
Capita Selecta Telecom	3
Code Generation for Embedded Systems	3
Coding Theory	6
Communication protocols	4
Compilers	6
Cryptography	3
Decision Engineering	4
Design and Implementation of Digital Circuits	3
Digital Signal Processing	4
Digital Technology in Telephony	3
Dynamic Processes	3
Evaluation of Computer Performances	3
Mathematics for Technology I	6
Multimedia Seminar	3
Multiprocessors and Reconfigurable Architectures	3
Multi-agent Learning Seminar	6
Operating Systems and Security	6
Parallel Systems	6
Pattern Recognition	3
Physical Communication	6
Research Topics in Software	6
Seminar Theoretical Computer Science I	6
Seminar Theoretical Computer Science II	6
Semiotic Dynamics and Emergent Semantics	6
Signal Theory	5
Software for Embedded Systems	3
Telecommunication Networks I	3
Voice, Image Coding, Media and Systems	6

\* ECTS: European Credit Transfer and Accumulation System

\*\* The Faculty cannot be held responsible for changes in the programme due to unexpected circumstances

## RESEARCH GROUPS INVOLVED IN THE MASTER'S PROGRAMMES

Two departments, the Department of Computer Science in the Faculty of Science and the Department of Electronics and Informatics in the Faculty of Engineering, jointly organise this master programme. Together, they include more than 200 researchers who cover a wide range of research topics.

### Computer Science ([cs.vub.ac.be](http://cs.vub.ac.be))

The Department of Computer Science combines seven research groups clustered in three areas: software and programming language engineering, web- and information systems, and artificial intelligence. In this department, there is a strong focus on research in the context of software application development. The different research groups have a strong track record in research projects, both nationally and internationally and in fundamental as well as in applied research projects. The majority of research projects have an industrial component.

You will find a short description of each research group below. More information can be found on their websites. More information about the department can be found at [cs.vub.ac.be](http://cs.vub.ac.be)

#### Artificial Intelligence Laboratory ([arti.vub.ac.be](http://arti.vub.ac.be))

Currently this laboratory focuses on two main research themes: the origins of language and robotic agents.

#### Adaptive Systems & Computational Intelligence Group ([como.vub.ac.be](http://como.vub.ac.be))

The research in this laboratory focuses on modelling natural phenomena using computational techniques and on the application of machine learning techniques to data mining and multi-agent systems.

#### Programming Technology Lab ([prog.vub.ac.be](http://prog.vub.ac.be))

This research group is active in the broad domains of software engineering and programming-language engineering. The research consists of designing, implementing and formalizing meta-level techniques to support programming, as well as the design, specification, formalization and implementation of new programming languages.

#### System and Software Engineering Lab ([ssel.vub.ac.be](http://ssel.vub.ac.be))

This group's research takes place in software engineering and, more specifically, in component-oriented, aspect-oriented and model-driven software development.

#### Semantics Technology and Applications Research Laboratory ([starlab.vub.ac.be](http://starlab.vub.ac.be))

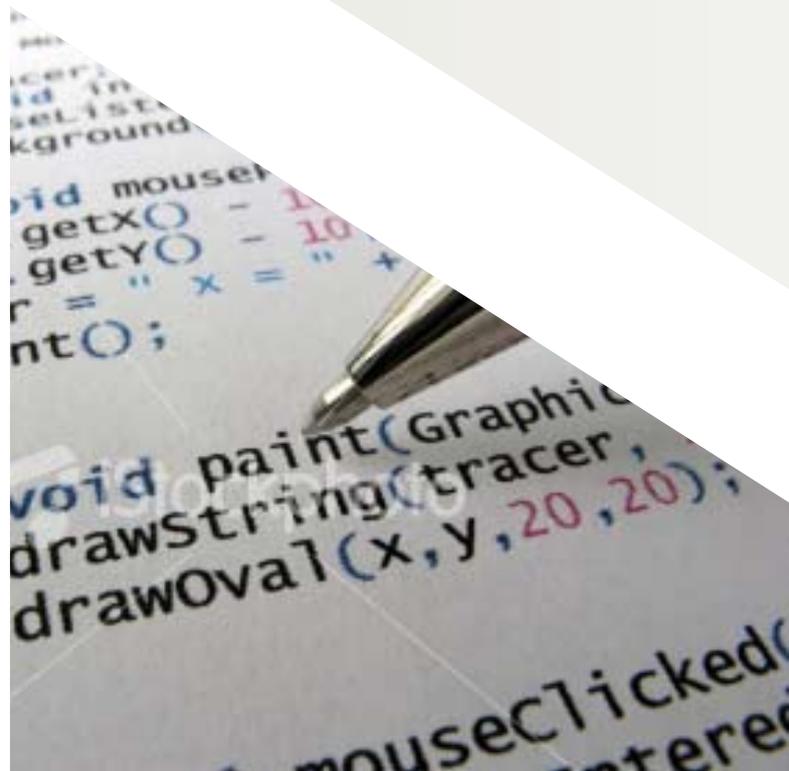
The focal point of this research group is research on databases and semantics. STARLab contributes to the state of the art in information-based technologies, both with research and development, and by applying expertise to real-life situations.

#### Laboratory for Theoretical Computer Science ([tinf2.vub.ac.be](http://tinf2.vub.ac.be))

The Theoretical Computer Science Research Group is primarily interested in the applications of logic to computer science, as in the fields of artificial intelligence, software engineering, non-monotonic reasoning, and in the theories of argumentation.

#### Web & Information Systems Engineering ([wise.vub.ac.be](http://wise.vub.ac.be))

The research scope of this group is Internet-based information systems. This scope ranges from classical websites, social web applications and new media applications to Virtual Reality (3D) and gaming applications. The emphasis is on conceptual modelling techniques, design and development methods.





## Electronics and Informatics (ETRO : [www.etro.vub.ac.be](http://www.etro.vub.ac.be))

Four research groups, the Laboratory for Micro- & Photonelectronics (*LAMI*), the Image Processing and Machine Vision Group (*IRIS*), the Laboratory for Digital Speech and Audio Processing (*DSSP*), and the Laboratory for Digital Telecommunications and Parallel & Distributed Processing (*TELE*), collaborate within ETRO.

Their joint research covers a wide range of generic technologies in *Information and Communication Technology*. The collaborative, trans-disciplinary research and development includes combined speech/audio and image/video processing in the context of multimedia research, new optoelectronic devices for ambient intelligence, mixed hardware and software design in security and surveillance applications, joint channel-source coding and wireless network protocols and applications. End-to-end design of complex, distributed, interactive and secure services and applications, including user communities, are tackled in collaboration with Communication and Media Sciences (VUB-SMIT). The group is associated with Inter-university Microelectronics Centre - Leuven (IMEC), and is a member of Institute for Broad Band Technology - Gent (IBBT).

Specific research themes include: (1) *Computational and Applied Mathematics in Physics (CAMP)* in conjunction with the Departments of Mathematics and Physics of VUB and ULB and the Department of Applied and Computational Mathematics, Princeton University; (2) *Audio-Visual Signal Processing (AVSP)* in conjunction with the Department of Computer Information and Engineering of the North Western Polytechnic University of Xi'an - China; and (3) *ICT in Health Care and Medicine* in conjunction with the University Hospital.

Would you like to know more? [www.etro.vub.ac.be](http://www.etro.vub.ac.be)

### Laboratory for Micro- & Photonelectronics (LAMI)

The main research goals of the LAMI group are inventing new electro-optical devices, designing analog circuits and exploring hybrid sensor technologies. In this context, the main fundamental research tracks are: III-V semiconductor device physics, mm waves and sub-mm waves and device physics based on nanotechnology. The applied research includes: mm-wave sensors and imaging, low-power communication, electro-optical components (e.g., Q-switched lasers, high-power detectors and 3-D cameras).

### Image Processing and Machine Vision Group (IRIS)

This group's fundamental research themes are: image and video coding, inverse problems in imaging, image analysis based on pattern recognition and computer vision, and motion analysis and tracking. The applied research is primarily concentrated in the following domains: medical imaging, multimedia systems, active vision in robotics, security and surveillance, and motion analysis and tracking.

### Digital Speech and Audio Processing (DSSP)

The fundamental research of the DSSP laboratory includes speech production and communication, spoken language theory, modelling of stochastic processes, sound metrics, auditory perception and audiovisual signal processing. More applied R&D activities are: computer-assisted language learning, voice conversion, speech enhancement, expressive speech synthesis and recognition.

### Telecommunications and Parallel & Distributed Processing (TELE)

The TELE group concentrates on various aspects of applied research: AI techniques for routing and protection, protocol engineering, embedded systems, reconfigurable computing, performance evaluation, wireless sensor networks, multicast concepts and applications.

## Admission

This master programme is intended for students with an academic Bachelor's degree in Computer Science. Acceptance to the programme is based on a review of each student's academic record and will be evaluated case-by-case. Non-EU nationals should apply before February 1. EU nationals should apply before June 1.

A good command of English is required for all students, except if English is your mother tongue. This is covered by a proof of having graduated at an English-speaking university or by:

<b>TOEFL</b>	(Test of English as a Foreign Language): paper & pencil: 550
<b>CBT</b>	(computer based): 213
<b>IBT</b>	(internet based): 80
<b>IELTS</b>	(International English Language Testing System): minimum band 6.5
<b>CAMBRIDGE</b>	Certificate in <b>Advanced English</b> : minimum grade B Certificate of <b>Proficiency</b> : minimum grade C

## Tuition

The regular yearly tuition for programmes consisting of between 54 and 66 credits is approximately € 533 (subject to yearly adjustments). This fee does not cover accommodation, travel, textbooks or study materials. In general, and in addition to the tuition, at least € 20, 000 is needed for a two-year programme.

## Scholarships

Yearly, one or more specific programmes are considered for scholarships from the Vrije Universiteit Brussel. The selected programme(s) are announced on our website in December (see [vub.ac.be/english/infofor/prospectivestudents/finance.html](http://vub.ac.be/english/infofor/prospectivestudents/finance.html)).

The Vrije Universiteit Brussel has many multilateral and bilateral cooperation agreements with universities and scholarship funds worldwide. For more information on scholarships, contact the International Relations & Mobility Office at [international.relations@vub.ac.be](mailto:international.relations@vub.ac.be).

The Erasmus Mundus - External Cooperation Window is a fairly new cooperation and mobility scheme which is complementary to other higher education initiatives such as Erasmus Mundus, Erasmus, Alfa, Alban and Edulink. This programme has been designed to foster cooperation in the field of higher education between the EU and third-world countries through a cooperation and mobility scheme addressing students and academic staff. An overview of the programmes involving the Vrije Universiteit Brussel can be found at [eacea.ec.europa.eu/extcoop/call/index.htm](http://eacea.ec.europa.eu/extcoop/call/index.htm)

BTC is the Belgian Technical Cooperation agency that supports developing countries. It mainly focuses on Algeria, Benin, Bolivia, Burundi, DR Congo, Ecuador, Mali, Morocco, Mozambique, Niger, Palestinian territories, Peru, Rwanda, Senegal, South Africa, Tanzania, Uganda, and Vietnam. Each year the Belgian Technical Cooperation grants some 120 scholarships to students from these countries for master's and PhD programmes.

(see [btctb.org](http://btctb.org) and [dgos.be/en/dgdc/grants/index.html](http://dgos.be/en/dgdc/grants/index.html)).



## Study environment

### Vrije Universiteit Brussel

The Vrije Universiteit Brussel is a dynamic and modern university with two parkland campuses in the Brussels Capital Region. The main campus in Etterbeek is home to seven faculties. This is the campus on which the master's programmes in Computer Science and Applied Computer Science are held. The medical campus and the University Hospital are located in Jette.

High-quality education and research are the focal points of our institution. Our research teams are internationally recognised in many disciplines of fundamental and applied research. We offer quality education to more than 9000 students. Add to that the almost 4500 students of our partner school, the Erasmushogeschool Brussels, the 400 students at the English-speaking Vesalius College, the 5000 students at the Centre for Adult Education with whom we share our campus, and the more than 150 research teams working on both campuses of the university, and you get one of the largest centres of knowledge in the capital of Europe. Thanks to our expertise and strategic location, the Vrije Universiteit Brussel is your ideal partner for excellent research and education with an outlook on Europe and the world.

The Vrije Universiteit Brussel is the Dutch-speaking offshoot of the French-speaking Université Libre de Bruxelles (ULB) that was founded in 1834 by a Brussels lawyer with Flemish origins, Pierre-Théodore Verhaegen. He wanted to establish a university that would be independent from the state and the church and where academic freedom would reign. Although in 1935 some courses were already given in Dutch, it was not until the 1969 academic year that the split became official. Nowadays, the Vrije Universiteit Brussel also offers a wide range of English-speaking programmes.

At the Vrije Universiteit Brussel, the academic year starts in late September and ends in early July. The academic year is composed of two semesters. Starting your studies in the second semester (February) is possible under certain conditions. Exams take place in January and June, with additional re-examinations in August for students who don't pass all of the examinations the first time.

### Etterbeek campus

The Etterbeek campus of the Vrije Universiteit Brussel gives you space to breath... literally. The buildings on the Etterbeek campus are spread out across a pleasant, green park area. Academic activities take place mainly in the many lecture halls and laboratories, all of which are supplied with up-to-date equipment. Modern sport facilities with sports halls, fitness rooms, tennis and squash courts, a football pitch, a running track, and a swimming pool can be found on-site. The student restaurant offers a large choice of meals and snacks at the self-service counters, and a refreshing beer can be enjoyed in the 'KultuurKaffee' and in the 'Opinio', the two bars on campus. The Etterbeek campus is easy to reach by train, tram, bus or metro from the city centre or from the outskirts of Brussels. Those travelling by car can leave their vehicle in one of the many covered car parks on the campus. Visitors travelling by train to the campus in Etterbeek can disembark at Etterbeek station, right next to the campus.

Many student rooms are available in the neighbourhood.

### The city of Brussels

Brussels is one of the most cosmopolitan cities in the world. It is more than 1000 years old. Today the name Brussels also stands for a city with 19 boroughs covering 162 km<sup>2</sup>, housing a million inhabitants and forming one of the three Regions of the federal Belgian state. Brussels is the capital of the Kingdom of Belgium. The city is officially bilingual (French and Dutch), although it boasts an astonishing variety of cultures, styles and nationalities. Nearly one third of its population is of foreign origin, and this makes for a unique atmosphere in which cultures interact easily with one another. English is rapidly becoming a lingua franca in Brussels because of the numerous international political organizations. Thus, language is not a barrier in the capital of Europe.

Brussels is also the headquarters of the European Commission, the European Council, the European Parliament, and the NATO. As the capital of Europe, Brussels is an international city like no other. In its role as the decision-making heart of Europe, Brussels has become an international capital where leaders from all over the world meet to wield their influence in policy decisions, as well as to do business. Its economy is largely service-oriented. Many multinationals have regional headquarters in Brussels, and it hosts many technological companies.

Brussels is located at the heart of Europe. Frequent high-speed trains connect Brussels to interesting cities like London, Paris, and Amsterdam. There are also many inexpensive flight connections to the major cities in Europe.

Despite the booming international attraction of Brussels, the city has preserved many aspects of its original atmosphere and history and offers a pleasant environment for student life where study is complemented by leisure and culture. Moreover, Brussels remains an accessible capital, characterized by a low cost of living.





Vrije  
Universiteit  
Brussel

### **Need more information about the Master of Applied Sciences and Engineering: Computer Science?**

More details and up-to-date information on the programme featured in this brochure can be found at

[E] [info@cs.vub.ac.be](mailto:info@cs.vub.ac.be)

[W] [computerscience.vub.ac.be](http://computerscience.vub.ac.be)

### **General information about the Vrije Universiteit Brussel**

[T] +32 2 629 20 10

[E] [info@vub.ac.be](mailto:info@vub.ac.be)

[W] [www.vub.ac.be](http://www.vub.ac.be)

### **Practical information (housing, visa...)**

[E] [welcome@vub.ac.be](mailto:welcome@vub.ac.be)