University *of Ljubljana*
Faculty *of Computer and Information Science*

SECOND CYCLE MASTER'S STUDY PROGRAMME
COMPUTER AND INFORMATION SCIENCE

HANDBOOK

Ljubljana, 2016

CONTENTS

About the study programme

1. General information

The 2nd cycle master's study programme in Computer and Information Science is a two-year programme (4 semesters) with a total load of 120 ECTS credits.

The professional title obtained is: *magister inženir / magistrica inženirka računalništva in informatike* (mag. inž. rač. in inf.).

2. Main objectives of the programme and general competences acquired

Main objectives of the programme
The master's study programme in Computer and Information Science is intended to extend, broaden and enhance knowledge and skills acquired in the first cycle, and for the mastery of advanced practical and theoretical knowledge in the field of computer and information science. The programme keeps abreast of rapid technological progress and offers a foundation for lifelong learning and career success in both the local and international environment. The programme also provides a basis for research and development work and for a career in academia. Holders of the master's degree are capable of assuming senior and leading positions in industry, management, science and research. The programme is divided into thematic sets, which enables students to select subjects with aligned content. On their own initiative students can involve themselves in projects being pursued in individual faculty research laboratories.

General competences acquired through the programme:
Masters of computer and information science build upon the competences acquired in the first cycle. Those that completed some other course in the first cycle will also flesh out their basic competence in computer and information science. Holders of the master's degree acquire the skills necessary to continue on to doctoral studies. The general competences acquired include:
- the ability to define, understand and creatively respond to professional challenges in the field of computer and information science,
- a knowledge of linear algebra, of types, integral and discrete transformation, the functions of multiple variables and vector analysis,
- knowledge and use of functional programming,
- knowledge and application of analysis of algorithms, spatial data structures, parallel algorithms, hash codes, algorithms with assumptions, heuristic programming,
- knowledge and practical use of advanced procedures for data analysis,
- knowledge of input-output and peripheral devices, buses, network interfaces and drivers.

Subject-specific competences acquired through the programme:
Through their selection of individual thematic sets, holders of the master's degree acquire the following competences (by set):

Artificial intelligence
- a knowledge of research algorithms, planning and conclusions, various methods of study, qualitative modelling, visualisation of models, combining algorithms, and interpreting predictions, connector rules and learning bots,
- practical use of advanced methods for data mining, data analysis and neuron networks,
- a knowledge of advanced methods of analysing complex signals such as video recordings.

Media technology
- providing information and creating interactivity with emphasis on the development of user and data-focused multimedia software solutions,
- modern concepts and methods in the area of e-education and distance learning in light of information and communication technology,
- the basics of computing perception, computer modelling of detection processes and the use of these models in constructing active cognitive robot systems,
- the basics of processing biomedical signals and images.

Hardware
- a knowledge of sensor networks with limited processor capacity and limited power supply,
- current processing methods and platforms as possible alternatives to classical electric transistor bivalent logic structures,
- practical knowledge in the area of hardware and software, basic processing of signals and images using digital methods,
- the ability to design and implement complete computer support for process management.

Networks and security
- a knowledge of the basics of cryptography and computer security,
- skills in protecting networks and privacy in modern information systems,
- the ability to set up an infrastructure for the operation of private, hybrid and personal clouds,
- a knowledge of the use of computers and information technology in forensic procedures and a knowledge of low-power sensor networks.

Software
- transparent knowledge of the field of interaction between humans and computers,
- the capacity for administrative management of processes linked to research, industry, education and other fields, the capacity to analyse material and information flows in production and service processes,
- a knowledge of the infrastructure for the operation of private, hybrid and personal clouds,
- skills in protecting networks and privacy in modern information systems.

Information systems and systems for administration
- skills in protecting networks and privacy in modern information systems,
- the ability to set up an infrastructure for the operation of private, hybrid and personal clouds,
- the ability to implement web browsers to extract structured data,
- mastery of IT in business systems in line with the business strategy.

Algorithms
- a knowledge of basic cryptography and computer security and the basics of numeric mathematics to solve practical problems,
- the ability to solve practical problems through theoretical computer science and creative technical tasks in the area of computer and information science, an understanding of basic topological concepts and constructions,
- the ability to teach algorithmic thinking in primary and secondary schools.

Computing methods
- an understanding of basic topological concepts and constructions and the basics of numeric mathematics to solve practical problems,
- solving creative technical tasks in the area of computer and information science,
- the ability to use mathematical approaches in selected technical fields and in the area of biology and genomes,
- a knowledge of alternative methods of processing and natural algorithms.

3. Admission requirements and enrolment criteria

The following candidates may enrol in the Master's Programme of Computer and Information Science:

a) Graduates of 1st cycle study programmes in computer and information science or study programmes related to natural or technological sciences (mathematics, physics, electrical engineering, chemistry and chemical technology, mechanical engineering, civil engineering);
b) Graduates of 1st cycle study programmes from fields other than those indicated above who have completed the following 1st cycle Computer and Information Science courses prior to enrolment: Programming 1, Discrete Structures, Introduction to Digital Circuits, Computer Systems Architecture, Introduction to Information Systems, or who covered the subject matter of these courses in their undergraduate studies.

If a decision is issued to limit enrolment, candidates are selected based on their:
- GPA achieved in undergraduate studies   40%,
- Results of the selection exam   60%.

The selection exam will cover chapters in mathematics, programming, algorithms and computer systems. It will take place in the first half of September, after the submission deadline for the study programme application.

4. Criteria for recognising knowledge and skills acquired prior to enrolment

The study programme enables the recognition of relevant knowledge acquired through formal and informal learning or experience. This knowledge can be recognised as part of the completed study requirements, at up to 6 ECTS for one set (the approximate study programme for a course) of knowledge acquired outside of the university. In the recognition process certificates and other documents are taken into account. Requests for recognition of acquired knowledge will be considered by the Faculty's Committee for Student Affairs and on its recommendation approved by the Faculty Senate.

5. Requirements for progression through the programme

The requirement for enrolling in Year 2 of the Master's Study Programme is to fulfil all study requirements from Year 1. For repeat enrolment in Year 1 students must complete at least half of the study requirements from Year 1 (i.e. 30 ECTS).

6. Requirements for completing the study programme

The requirements for completing the study programme are the following for all students: fulfilled study obligations in enrolled courses, equivalent to at least 96 ECTS; a Master's thesis prepared and submitted in accordance with the relevant rules, equivalent to 24 ECTS; a successful public defence of the Master's thesis.

7. Transferring between study programmes

Transfers from other programmes are possible after the 1st year of study. Requirements for transferring to the Master's Programme of Computer and Information Science from other Master's programmes are:

- Fulfilled requirements for enrolment in the Master's Study Programme in Computer and Information Science.
- Fulfilled requirements for enrolment in Year 2 of the study programme in which the student is currently enrolled, with the additional requirement that the student has fulfilled all requirements for the obligatory courses of the study programme: Mathematics II, Programming, Algorithms, Computer Systems, or equivalent courses at other higher education institutions, in which case the equivalence of the courses is assessed by the Faculty's Committee for Student Affairs.
- Fulfilled additional obligations defined by the relevant Faculty body based on comparison of the programme from which the student is transferring and the Master's Study Programme in Computer and Information Science.

Students can be granted consent for parallel enrolment in another study programme on the basis of an individual application and their study performance.

8. Methods of assessment

The methods of assessment are defined in the syllabus for each individual course. The general rules for the assessment of knowledge are regulated by the Faculty's Study Rules and Regulations. For all courses, knowledge is assessed in the form of continuous assessment and a final assessment. Continuous assessment may include homework, midterm exams, seminars and project work with oral defences. Final assessments are in the form of a written and/or oral exam. All assessments are graded on a scale from 1 to 10, where 6 – 10 are passing grades and 1 – 5 failing grades, or descriptively "passed" / "failed".

9. Structure of the study programme

The study programme is composed of 4 obligatory courses, 31 specialist elective courses, 3 general elective courses and the Master's thesis. Elective courses from other study programmes can be selected but are not included here.

Year 1 is composed of four obligatory courses. Students also choose four specialist elective courses and general elective courses with a total of at least 12 ECTS. In Year 2 students choose 6 specialist elective courses and work on their Master's thesis, which has a load of 24 credits. The courses are selected under the supervision of a teacher (mentor or tutor).

Students choose specialist elective courses on enrolment (during the course of two years there are 10 different specialist elective courses in the syllabus) so that 6 of the courses are chosen from a maximum of any two thematic modules (therefore they can be chosen only from one module), and 4 courses can be chosen at will (from a list of offered specialised elective courses, regardless of the module). The specialist elective courses are chosen from the list of specialist elective courses and up to 2 courses can be chosen from the modules of the university study programme Computer and Information Science. Students cannot choose elective courses with similar content to the ones they have already taken.

The general elective courses Extracurricular Professional Activities I and II have a workload of 3 ECTS. Their aim is to assign ECTS credits to students' extracurricular professional but non-profit work that is relevant for computer and information science, provided they are not covered in the study programme. Students are also offered English classes in three difficulty levels, A, B and C, each one equivalent to 3 ECTS. Students cannot choose an English language elective course if they have already taken it in the 1st cycle. The Faculty also offers a general elective course Selected Topics in Computer and Information Science, which has a workload of 6 ECTS and comprises lectures by visiting professors from other universities. The general elective subject Data Mining and Visualisation is intended for students in other programmes, especially in the fields of social studies and the humanities.

10 . Study programme

OVERVIEW OF THE STUDY PROGRAMME

	Semester	ECTS	Hours of student work (HSW)
Year 1			
Obligatory courses, specialist, and general elective courses	**Winter**	30	900
Obligatory courses, specialist, and general elective courses	**Summer**	30	900
Year 2			
Specialist and general elective courses, Master's thesis	**Winter**	30	900
Specialist and general elective courses, Master's thesis	**Summer**	30	900
Total			3600

Legend:

L = number of lectures per week,

S = number of seminar hours,

T = number of tutorial exercises per week,

ECTS = number of ECTS points.

Each semester lasts 15 weeks.

YEAR 1

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63506	Mathematics II	45/0/30		6
63507	Programming	45/10/20		6
	Specialist elective	45/0/30		6
	Specialist elective	45/0/30		6
	General elective	45/0/30		6
63508	Algorithms		45/20/10	6
63509	Computer Systems		45/0/30	6
	Specialist elective		45/0/30	6
	Specialist elective		45/0/30	6
	General elective		45/0/30	6

YEAR 2

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
	Specialist elective	45/0/30		6
	Specialist elective	45/0/30		6
	Specialist elective	45/0/30		6
	Master's thesis	0/30/0		12
	Specialist elective		45/0/30	6
	Specialist elective		45/0/30	6
	Specialist elective		45/0/30	6
	Master's thesis		0/30/0	12

Note: Students choose specialist elective courses on enrolment (during the course of two years there are 10 different specialist elective courses on the syllabus) so that 6 of the courses are chosen from a maximum of any two thematic modules (therefore they can be chosen only from one module), and 4 courses can be chosen at will (from a list of offered specialised elective courses, regardless of the module).

SPECIALIST ELECTIVE COURSES

I. Artificial Intelligence

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63510	Artificial Intelligence		45/10/20	6
63519	Machine Learning	45/6/24		6
63525	Data Mining		45/20/10	6
63513	Perception in Cognitive systems	45/0/30		6
63520	Introduction to Bioinformatics	45/20/10		6
63551	Web Information Extraction and Retrieval		45/10/20	6
63514	Biomedical Signal and Image Processing	45/0/30		6
63522	Advanced topics in computer vision		45/10/20	6
63554	Image based biometry	45/10/20		6
63555	Natural language processing	45/10/20		6

II. Media technologies

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63527	Interaction and Information Design		45/20/10	6
63518	E-learning	45/10/20		6
63513	Perception in Cognitive Systems	45/0/30		6
63514	Biomedical Signal and Image Processing	45/0/30		6
63516	Digital Signal Processing	45/10/20		6
63523	Computer-Based Sound Production	45/0/30		6
63522	Advanced topics in computer vision		45/10/20	6
63554	Image based biometry	45/10/20		6
63555	Natural language processing	45/10/20		6
63553	Advanced Computer Graphics	45/0/30		6

III. Hardware

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63511	Wireless Sensor Networks		45/10/20	6
63512	Unconventional Computing	45/20/10		6
63516	Digital Signal processing	45/10/20		6
63543	Computer-Based Process Control	45/10/20		6
63523	Computer-Based Sound Production	45/0/30		6
63514	Biomedical Signal and Image Processing	45/0/30		6

IV. Computer Networks and Security

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63528	Cryptography and Computer Security	45/10/20		6
63521	Information Security and Privacy	45/0/30		6
63541	Cloud Computing	45/20/10		6
63530	Digital Forensics		45/0/30	6
63511	Wireless Sensor Networks		45/10/20	6

V. Software

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63550	Human-Computer Interaction	45/0/30		6
63515	Modern Software Development Methods		45/10/20	6
63541	Cloud Computing	45/20/10		6
63533	Operations Management	45/10/20		6
63521	Information Security and Privacy	45/0/30		6

VI. Information and Management Systems

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63521	Information Security and Privacy	45/0/30		6
63514	Cloud Computing	45/20/10		6
63551	Web Information Extraction and Retrieval		45/10/20	6
63526	IT Governance		45/10/20	6
63555	Natural language processing	45/10/20		6

VII. Algorithmics

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63528	Cryptography and Computer Complexity	45/10/20		6
63517	Computability and Computational Complexity	45/0/30		6
63542	Computational Topology		45/10/20	6
63532	Discrete Mathematics		45/0/30	6
63522	Numerical Mathematics		45/0/30	6
63547	Teaching Algorithmic Thinking	45/20/10		6

VIII. Computational Methods

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63542	Computational Topology		45/10/20	6
63532	Discrete Mathematics		45/0/30	6
63522	Numerical Mathematics		45/0/30	6
63520	Introduction to Bioinformatics	45/20/10		6
63519	Machine Learning	45/6/24		6
63512	Unconventional Computing	45/20/10		6
63522	Advanced topics in computer vision		45/10/20	6
63554	Image based biometry	45/10/20		6
63553	Advanced Computer Graphics	45/0/30		6

SPECIALIST ELECTIVE COURSES

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63544	Research seminar	15/45/0		12
63545	Topical Research Themes I	45/10/20		6
63546	Topical Research Themes II		45/10/20	6

GENERAL ELECTIVE COURSES

No.	Study unit	Semester 1 L/S/T	Semester 2 L/S/T	ECTS
63534	Extracurricular professional activities I	5/0/0		3
63535	Extracurricular professional activities II		5/0/0	3
63536	Topics in Computer and Information Science		45/0/30	6
63549	Data Mining and Visualisation	45/0/30		6

11. Information on elective courses and mobility

General elective courses can be chosen from courses offered by the University of Ljubljana and other universities at 2nd cycle education level. The Faculty of Computer and Information Science has numerous contracts with foreign universities for the Erasmus+ exchange programme. Students who partake in Erasmus student exchange programmes at another university may transfer up to 30 ECTS worth of obligations per semester completed at the foreign institution. A thesis completed at another university cannot be recognized as a completed Master's thesis unless approved by the Faculty in advance.

12. Information on the comparability of the programme

Comparable foreign study programmes (name of the programme, institution, country):

- Master's programme (Laurea specialistica) in Computer Science, Universita degli studi di Trento, Italia, http://portale.unitn.it/
- Master-Studium-Informatik, Fakultät Elektrotechnik und Informatik, Technische Universität Berlin, Germany, http://www.eecs.tu-berlin.de/
- Master's Degree Programme in Software Development, Department of Computer Sciences, University of Tampere, Finland, http://www.uta.fi/english/

13. Short descriptions of individual courses

Short descriptions are available on the faculty website.