UNIVERSITY OF LJUBLJANA
Faculty of Computer and Information Science

Contents

1 Undergraduate programmes

The Faculty of Computer and Information Science offers two undergraduate educational programmes:

- a four year programme (six semesters of lectures, 15 weeks of practice, 6 months of Diploma thesis work), which leads to the degree "Dip.Ing. of Computer and Information Science", and
- a five year "university programme" (nine semesters of lectures, 6 months of Diploma thesis work), which leads to the degree "University Dipl. Ing. of Computer and Information Science".

The entry requirement for the four year programme is completition of a four year secondary education. For the five year "university" programme the national secondary school baccalaureate is mandatory. The four year programme is more application oriented, while the five year programme offers more extensive and in depth theoretical knowledge. Only graduates of the five year programme can continue their education at the postgraduate level.

Both undergraduate programmes have a general core-curriculum which consists mainly of mathematics and theoretical foundations of computer and information science, and three elective modules in:

- Information Science,
- Computer Logic and Systems, and
- Computer Software.

Students must choose one of the three modules after the first year on the four year programme and after the second year on the five year "university" programme.

2 Five year "University" undergraduate programme

2.1 FIRST year

General Courses	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
Programming I	3	0	3				7	
Calculus I	3	3	0	3	2	0	7.5	6
Discrete structures	3	2	0	2	3	0	6	6
Physics	3	3	0	3	2	0	7.5	6
Programming II				3	0	3		7
Theory of Switching Circuits				3	0	3		7
Total	12	8	3	14	7	6	28	32

2.2 SECOND year

General Courses	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
Foreign Language (English)	0	3	0				3.5	
Algorithms and Data Structures I	3	0	3				7	
Calculus II	3	3	0				7.5	
Computer Systems Architecture I	3	0	3				7	
Linear Algebra	2	2	0	2	2	0	5	5
Numerical Methods				3	0	3		7
Algorithms and Data Structures II				3	0	3		7.5
Computer Systems Architecture II				3	0	3		7
Introduction to Information Theory				3	0	0		3.5
Total	11	8	6	14	2	9	30	30

2.3 THIRD year

Courses in Computer Logic and Systems	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
Probability and Statistics	3	3	0				7.5	
Logic Design of Computers	3	0	3				7	
Computer Organization and Microprogramming	3	0	3				7	
Digital Electronics	3	0	3	3	3	0	7.5	7.5

Combinatorics				2	1	0		3.5
Modelling and Simulation				3	1	2		7
Input-Output Devices and Systems				3	0	3		7
System Theory				3	2	0		6
Total	12	3	9	14	7	5	30	30

Courses in Computer Software	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Probability and Statistics	3	3	0				7.5	
Software Engineering	3	1	2				7	
Introduction to Databases	3	1	2				7	
Theoretical Fundamentals of Computer Science I	3	3	0				7.5	
Combinatorics				2	1	0		3.5
Modelling and Simulation				3	1	2		7
Principles of Programming Languages				3	3	0		7
System Theory				3	2	0		6
Theoretical Fundamentals of Computer Science II				3	3	0		7.5
Total	12	8	4	14	10	2	29	31

Courses in Information Science	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Probability and Statistics	3	3	0				7.5	
Software Engineering	3	1	2				7	
Databases	3	1	2	3	1	2	7.5	7
Information Systems	3	1	2	3	1	2	7.5	7
Combinatorics				2	1	0		3.5
Modelling and Simulation				3	1	2		7
System Theory				3	2	0		6
Total	12	6	6	14	6	6	29.5	30.5

2.4 FOURTH year

Courses in Computer Logic and Systems	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Optimization Methods	2	2	0				5	
Computer Systems Performance and Evaluation	3	0	3				7	
Digital Signal Processing	3	0	3				7.5	

Graphic Techniques and Procedures	3	0	2				6	
Operating Systems	3	0	2	3	0	3	6	7.5
Computer Networks and Services				3	0	2		6
Computer Reliability and Diagnostics				3	0	3		7.5
Cellular Structures and Systems				3	1	2		7.5
Total	14	2	10	12	1	10	31.5	28.5

Courses in Computer Software	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Optimization Methods	2	2	0				5	
Computer Systems Performance and Evaluation	3	0	3				7	
Business Economics	2	0	0				3	
Artificial Intelligence and Symbolic Programming	3	1	2	3	0	2	7	6
Operating Systems	3	0	3	3	0	2	7	6
Computer Networks and Services				3	0	2		6
Computer Graphics				3	3	0		7
Compilers				3	0	2		6
Total	13	3	8	15	3	8	29	31

Courses in Information Science	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Optimization Methods	2	2	0				5	
Computer Systems Performance and Evaluation	3	0	3				7	
Operating Systems	3	0	2				6	
Design and Management of Information Systems	3	1	2	2	2	0	7	5
Economics and Business Functions	2	0	0	3	3	0	3	7
Computer Networks and Services				3	0	2		6
Models and Decision Systems				3	3	0		7
Operations Research				3	1	2		7
Total	13	3	7	14	9	4	28	32

2.5 FIFTH year

Courses in Computer Logic and Systems	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Business Economics	2	0	0				3	

Adaptive Systems	3	3	0				8	
Communication Systems and Information Services (Telematics)	3	3	0				8	
Programmable Logic Circuits	3	0	3				8	
Seminar	0	0	2				3	
Diploma Thesis				6 months				30
Total	11	6	5	6 months			30	30

Courses in Computer Software	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Digital Signal Processing	3	0	3				7.5	
Knowledge Engineering	3	2	0				7.5	
Selected Topics in Software	3	0	3				7.5	
Software Technology	3	0	3				7.5	
Diploma Thesis				6 months				30
Total	12	2	9	6 months			30	30

Courses in Information Science	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Methods of Communication	3	3	0				7.5	
Selected Topics in Informatics	3	3	0				7.5	
Artificial Intelligence	3	0	2				7.5	
Technology of Information Systems	3	0	3				7.5	
Diploma Thesis				6 months				30
Total	12	6	5	6 months			30	30

3 Short contetnts

3.1 FIRST year

3.2 SECOND year

Numerical Methods [20021] **(ENG B)**

Description: Basic methods of numerical mathematics.
Contents: Numerical solution of problems, systems of linear equations, nonlinear equations, interpolation and aproximation, numarical integration and differentiation, numerical solution of ordinary differential equations.

Introduction to Information Theory [20127] **(ENG B)**

Description: Introduction to Information Theory in relation to information transport through communication channels;
Contents: First, definition of entropy and information is given, followed by the description of particular elements of communication system, from source of information, through communication channel till discrete channel and analog line. The channel capacity and rate are defined. The coding is given in an order as it appears in the communication system. First, the coding of source is described (1'st Shannon theorem, Huffman's procedure), followed by the safe coding (2'nd Shannon theorem, linear block codes, cyclic codes, linear feedback shift registers). Different decoding procedures are given for detecting and dispatching errors. In the second part, the description of signals and systems that serve in the actual information transport, is outlined. The relevant mathematical tools are given, namely Fourier, Laplace and z - transforms. The 3'rd Shannon theorem (also called sampling theorem), that enables sampling without any loss of information and reconstruction of original analog signal, is detailed.

3.3 THIRD year

3.3.1 Computer Logic and Systems

Computer Organization and Microprogramming [20122] **(ENG A)**

Description: Methods and techniques for process troughput improvement
Contents: Microprogrammed control unit, its building blocks, advantages and disadvantages. Methods for defining microinstruction format. Regular microprograms and their usage. Time optimization of horizontal microprograms. Low cost controllers based on microprogramming scheme. Microdiagnostic: concept of hard core, online and offline diagnostic tests. Basic algorithms for fast execution of arithmetic operations, integer representation with focus on floating point representation. Elementary data transformations and introduction of RISC concept. Long term trends in time needed for elementary operations and memory access time. Short description of some most known commercial versions of RISC architectures: Sparc, HP High precision, IBM RS6000 and MIPSR4000.

3.3.2 Computer Software

3.3.3 Information Science

3.4 FOURTH year

3.4.1 Computer Logic and Systems

Operating Systems [20139] **(ENG B)**

Description: Fundamental issues in modern operating systems and in-depth knowledge in selected areas of operating systems used in the design and maintenance of computer systems.
Contents: Introduction and historical overview. Operating systems types and organizations. Basics on computer organization. Interrupts. Operating system structures. System calls. Kernel. Device management. I/O operations. Programming model of an I/O unit. Buffering. Device drivers. Process management. Process. Operations on processes. Threads. Basics on process scheduling. Selected scheduling strategies. Process communication. Process interaction and synchronization. Critical section problem. Programming solutions. Semaphores. Other classical problems of synhronization. High-level synchronization. Monitors. Implementation issues. Deadlocks. Prevention, avoidance, detection, and recovery. Student homeworks (selected topics in process management, memory management, file systems, distributed computing, security and protection, selected operating systems, other topical subjects).

Computer Reliability and Diagnostics [20058] **(ENG B)**

Description:: Methods for estimation and improvment of computer system reliability
Contents: Basic of reliability theory. Basic characteristics of computer reliability. Parameters of reliability evaluation. Reliability of components. Reliability of hardware devices. Basic of system reliability. Redundant systems. The models of software reliability. Increase of system reliability based on observed data. Computer diagnostics. Relation of quality. Computer reliability standards. Overview of computer tools for estimation of reliability.

3.4.2 Computer Software

Artificial Intelligence and Symbolic Programming [20141] **(ENG B)**

Description: Techniques of Artificial Intelligence, and skills of their application and implementation by means of symbolic programming
Contents: Methods for searching problem spaces: state space and AND/OR graphs, basic search techniques and their time and space complexity, heuristic search.A* algorithm, admissibility of A*. Space-

saving variants of heuristic search. Means-ends planning. Knowledge representation and expert systems. Machine learning: the problem of learning from examples, induction of rules and decision trees, handling noise, inductive logic programming. Genetic algorithms. Qualitative reasoning. Implementation of the techniques covered.

3.4.3 Information Science

Operating systems [20060] **(ENG B)**

Description: General knowledge of typical operating systems. Methods for estimating the suitability of an operating system to support given activities, and for configuring applications on modern systems.
Contents: Comparison of typical operating systems. Basics on proces management, storage management, protection and security. Multiuser systems. Operating system shells and their programming. Open systems. Graphic user interfaces. Introduction to distributed systems. Client-server. Services on distributed systems. Systems administration. File system organization and maintenance. Software portability. Operating system configuration to support application software. Student homeworks (selected topics in process management, memory management, file systems, distributed computing, security and protection, selected operating systems, other topical subjects).

Economics and Business Functions [20137] **(ENG A)**

Description: Socio-economic environment in the corporation. Economic and other concepts linked to the business process, and some aspects of their practical use.
Contents: Social grouping as a business system. Socio-economic and system's aspect of business economics. Enterprise. Elements of business process and economising. Costs and their classifications, sale prices, revenues, costs in sold goods and business result. Assets and their sources, equity and debts. Information functions and ratios. Organisational science and theory of organisation. Relationships. Strategy. Corporate governance and management. Structures. Processes. Systems. Roles. Human resources management. Technical function. Purchasing. Production and service providing. Quality management. Sales and marketing. Finance.

3.5 FIFTH Year

3.5.1 Computer Logic and System

Programmable Logic Systems [20156] **(ENG A)**

Description: Programmable logic system fundamentals and their application.
Contents: Introduction to programmable logic circuits: PAL, EPLD, EFPG, ROM, RAM, and GALL. Use of programmable logic circuit for decision and sequential logic functions, methods and examples. Programming with ABEL, and VHDLs.

3.5.2 Computer Software

Software Technology [20159] **(ENG B)**

Description: Development of applications in a database environment. Comparison of structured and object-oriented systems analysis and design methods.
Contents: Software life cycle and software requirements definition. Strtuctured system analysis and design techniques: data modelling, data-flow diagrams, Jackson structures, SSADM. Relational data analysis, normalization. CASE tools, data dictionary sistems, and program generators. Object-oriented analysis and design.

3.5.3 Information Science

Artificial Intelligence [20161] **(ENG B)**

Description: Techniques of Artificial Intelligence and their application.
Contents: What is Artificial Intelligence? Overview of the field and examples of applications.
Methods for searching problem spaces: state space, AND/OR graphs, basic search techniques and their time and space complexity, heuristic search. Means-ends planning. Knowledge representation and expert systems. Machine learning: the problem of learning from examples, induction of rules and decision trees, handling noise, inductive logic programming.

Technology of Information systems [20162] **(ENG B)**

Description: Concepts and models in information systems and software quality engineering.
Contents: Information technology standards and software engineering standards. Quality of information systems development. Methods and models in information systems and software quality engineering: ISO 9000 family of standards, CMM model, SPICE, COBIT. An overview of best practices in modern information systems and software development.

Methods of Communication [20079] **(ENG A)**

Description Basic concepts of human communication and techniques for written, oral and web communication.
Contents: Theoretical basis of communication and definition of basic terms (types of communication, roles, message, feedback, influence of culture, perception). Written communication (writting of technical texts),oral communication (public presentation), web communication (building of web presentations).

4 Four year undergraduate programme

4.1 FIRST year - Four year undergraduate programme

General Courses	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
Foreign Language (English)	0	3	0				3.5	
Application Software	1	0	4				6	
Introduction to Programming I	3	0	3				7.5	
Introduction to Computer Architecture I	3	0	3				7	
Discrete Mathematics	3	3	0	3	3	0	7	7.5
Introduction to Programming II				3	0	3		7
Introduction to Computer Architecture II				3	0	3		7
Calculus I				3	1	2		7.5
Total	12	8	4	14	10	2	31	29

4.2 SECOND year - Four year undergraduate programme

Courses in Computer Logic and Systems	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
Calculus II	3	3	0				7	
Introduction to Algorithms and Data Structures I	3	1	2				7.5	
Logic Structures and Systems I	3	0	3				7.5	
Digital Electronics I	3	1	2				7	
Introduction to Algorithms and Data Structures II				3	1	2		7
Business Economics				2	2	0		5
Digital Electronics II				3	1	2		7
Input-Output Devices				3	1	2		7
Computer Systems Organisation				2	2	0		5
Total	12	5	7	13	7	6	29	31

Courses in Computer Software	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
Calculus II	3	3	0				7	
Introduction to Algorithms and Data Structures I	3	1	2				7.5	
Programming Languages	3	1	2				7.5	

Introduction to Databases	3	0	3				7	
Introduction to Algorithms and Data Structures II				3	1	2		7
Business Economics				2	2	0		5
Introduction to Information Systems				3	0	3		7
Introduction to Probability and Statistics				2	2	0		5
User Interfaces				3	0	3		7
Total	12	5	7	13	7	6	29	31

Courses in Information Science	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
Calculus II	3	3	0				7	
Introduction to Algorithms and Data Structures I	3	1	2				7.5	
Information Systems	3	0	3				7.5	
Databases I	3	0	3				7	
Introduction to Algorithms and Data Structures II				3	1	2		7
Business Economics				2	2	0		5
Databases II				3	0	3		7
Statistics and Data Analysis				2	2	0		5
Information Systems Design				3	0	3		7
Total	12	5	7	13	7	6	29	31

4.3 THIRD year - Four year undergraduate programme

Courses in Computer Logic and Systems	**Hours per week**						**ECTS Credits**	
	Fall			**Spring**			**Fall**	**Spring**
System Software	3	0	2				6	
Business Functions	2	2	0				5	
Introduction to Computer Graphics	2	0	2				5	
Introduction to Modelling and Simulation	3	0	3				7	
Digital Signal Processing	3	1	2				7	
Computer Communications				3	0	3		7
Real Time Systems				3	0	3		7
Logic Structures and Systems II				3	0	3		7.5
Computer Equipment Evaluation				2	1	1		5
Distributed Structures				2	0	1		3.5
Total	13	3	9	13	1	11	30	30

Courses in Computer Software	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
System Software	3	0	2				6	
Business Functions	2	2	0				5	
Introduction to Modelling and Simulation	3	0	3				7	
Numerical Methods	3	2	0				6	
Programming Systems Design I	3	0	2				6	
Computer Communications				3	0	3		7
Programming Systems Design II				3	1	2		7
Introduction to Computer Graphics				2	0	2		5
Applications Development				1	0	2		3.5
Methods of Artificial Intelligence				3	0	3		7.5
Total	14	4	7	12	1	12	30	30

Courses in Information Science	Hours per week						ECTS Credits	
	Fall			Spring			Fall	Spring
System Software	3	0	2				6	
Business Functions	2	2	0				5	
Organization Theory	2	2	0				5	
Accounting	2	2	0				5	
Application Development Tools and Techniques	3	1	2				7	
Legal and Social Aspects of Informatics	2	0	0				2.5	
Computer Communications				3	0	3		7
Project Management and Organization of Information Systems				3	1	2		7
Information Systems Standards and Quality Assurance				2	0	1		3.5
Communication Methods				2	2	0		5
Decision Systems				3	0	3		7
Total	14	7	4	13	3	9	30.5	29.5

4.4 FOURTH year - Four year undergraduate programme

General Courses	Hours per week		ECTS Credits	
	Fall	Spring	Fall	Spring
Practice	15 weeks		30	
Diploma Thesis		6 months		30
Total	15 weeks	6 months	30	29

5 Short contents

5.1 FIRST year

5.2 SECOND year

5.2.1 Computer Logic and Systems

Calculus II [70010] **(ENG B)**

Description: Introduction to further concepts of mathematical analysis and their application to computer and other sciences.
Contents: Plane curves: parametrized curves, curves in polar coordinates, implicit curves. Series: number series, power series, trigonometric series. Functions of two variables: graphic representation, partial derivatives and the differential, local and conditional extrema, computing double integrals. Basics on differential equations.

Introduction to Algorithms and Data Structures I [70011] **(ENG B)**

Description: Introduction to sorting algorithms and operations on lists and trees.
Contents: Sorting algorithms: sorting arrays (sorting by straight insertion, straight selection, and straight exchange; insertion sort by diminishing increment, heapsort, quicksort); external sorting (natural merging, balanced multiway merging, polyphase sort). Time complexity of sorting algorithms. Lists as abstract data types: basic operations, stacks, queues. Tree structures. Binary search trees: tree traversal, search, insertion, and deletion. Balanced trees: balanced tree insertion and deletion. Time complexity of tree search and insertion.

Logic Structures and Systems I [70015] **(ENG B)**

Description: Elements of digital techniques and logic design
Contents: Boolean algebra is defined first. The description of different analytical forms for logical problems is shown, together with the definition of all diadic logical operators. SSI implementations of the most important operators are given (DTL, TTL, MOS). Next, several features of decision functions are detailed (linear, monotone, unite, threshold, symetric, probabilistic functions). Implementation of MSI and LSI operators (MX, D, K, PLD) and the relevant design procedures follows. In the second part, sequential circuits are described. First, all relevant flip-flops are given. Then, the design of memory equations is detailed, followed by the complete structural synthesis. The abstract analysis and synthesis of finite state machines is shown. The optimisation of states, translation of Regular Expressions into State Transition Diagram and state coding is

Computer Systems Organisation [70019] **(ENG A)**

Description: Computer system hardware and software fundamentals.
Contents: Hardware and software modularity, distributed computer systems, environment computer system performances, menaging computer systems

5.2.2 Computer Software

Calculus II [70010] **(ENG B)**

Description: Introduction to further concepts of mathematical analysis and their application to computer and other sciences.
Contents: Plane curves: parametrized curves, curves in polar coordinates, implicit curves. Series: number series, power series, trigonometric series. Functions of two variables: graphic representation, partial derivatives and the differential, local and conditional extrema, computing double integrals. Basics on differential equations.

Introduction to Algorithms and Data Structures I [70011] **(ENG B)**

Description: Introduction to sorting algorithms and operations on lists and trees.
Contents: Sorting algorithms: sorting arrays (sorting by straight insertion, straight selection, and straight exchange; insertion sort by diminishing increment, heapsort, quicksort); external sorting (natural merging, balanced multiway merging, polyphase sort). Time complexity of sorting algorithms. Lists as abstract data types: basic operations, stacks, queues. Tree structures. Binary search trees: tree traversal, search, insertion, and deletion. Balanced trees: balanced tree insertion and deletion. Time complexity of tree search and insertion.

5.2.3 Information Science

Calculus II [70010] **(ENG B)**

Description: Introduction to further concepts of mathematical analysis and their application to computer and other sciences.
Contents: Plane curves: parametrized curves, curves in polar coordinates, implicit curves. Series: number series, power series, trigonometric series. Functions of two variables: graphic representation, partial derivatives and the differential, local and conditional extrema, computing double integrals. Basics on differential equations.

Introduction to Algorithms and Data Structures I [70011] **(ENG B)**

Description: Introduction to sorting algorithms and operations on lists and trees.

Contents: Sorting algorithms: sorting arrays (sorting by straight insertion, straight selection, and straight exchange; insertion sort by diminishing increment, heapsort, quicksort); external sorting (natural merging, balanced multiway merging, polyphase sort). Time complexity of sorting algorithms. Lists as abstract data types: basic operations, stacks, queues. Tree structures. Binary search trees: tree traversal, search, insertion, and deletion. Balanced trees: balanced tree insertion and deletion. Time complexity of tree search and insertion.

5.3 THIRD year

5.3.1 Computer Logic and Systems

Introduction to Computer Graphics [70035] **(ENG A)**

Description: Typical components of graphical computer systems, configuration of such systems and of applications with graphical support. Practical programming of smaller applications .
Contents: Introduction to computer graphics. Configuring the computer graphics interface. Computer graphics libraries for high level programming languages. Compatibility of computer graphics applications. Integration of images into application. Graphic image convertions and standards.

Logic Structures and Systems II [70039] **(ENG B)**

Description: Computer structures in the sense of logic and technology
Contents: Number systems and transformations are described first, equally for integer and decimal values. It is followed by the fixed and floating point arithmetic, together with the modulo arithmetic. Then, the basic modules like adders/subtractors, multipliers are shown, with the instructions for modular design. The description of counters, coders, ALU unit, follows. The design of multilevel logic comes next, where the procedure to avoid hazards is shown. In the second part we start with different ways of synchronization of sequential circuits, where some instructions for hazard free design are given. It is followed by the two formal methods for the description of finite state machines: ASM (Algorithmic State Machine) and VHDL (VLSI Hardware Description Language). Then the procedures for the reduction of states and for saving codes are given. The description of computer organization comes next, followed by the I/O organization, protocols for communication between resources, and the design of control unit based on FSM and microprogramming unit. Finally, the simplified model of the complete computer is detailed to some extent.

5.3.2 Computer Software

5.3.3 Information Science

Communication Methods [70056] **(ENG A)**

Description: Basic concepts of human communication and techniques for written, oral and web communication.
Contents: Theoretical basis of communication and definition of basic terms (types of communication, roles, message, feedback, influence of culture, perception). Written communication (writting of technical texts), oral communication (public presentation), web communication (building of web presentations).

Decision Systems [70057] **(ENG B)**

Description: Introduction to decision theory and overview of decision support tools
Contents: Overview of decision making. Decision models. Decision support systems. Knowledge representation and acquisition. Handling of uncertainties. Decision trees. Decision support systems and tools and their inclusion in information systems. Data warehousing. OLAP. Induction of decision models from data. Data mining.