

Student Guide to MSc Studies

Institute of Informatics, University of Szeged

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3. Contents

1. Title page.....	1
2. Contact information.....	2
3. Contents.....	3
4. Foreword.....	4
5. Organization.....	5
6. Main courses.....	6
7. Education.....	8
8. Research.....	10
9. Miscellania.....	11
10. Resources	12
11. Description of Software Information Technology MSc program.....	13

4. Foreword

Systematic education in computer science at the University of Szeged was launched within the Mathematical Institute at the end of the 1950's. Professor László Kalmár, a Kossuth laureate mathematician recognized the importance of that new-born science, and used his authority to put informatics to the place it belongs. He offered the first computer courses at the University of Szeged, and had a decisive role in starting computer science programs in 1963, and in founding Computer Science department within the Bolyai Mathematical Institute.

From that time the education, the research and the infrastructural and human resources that provide the base for that activities have undergone profound changes. One of the most important steps of that development came in 1990, when the independent Institute of Informatics was founded within the Faculty of Natural Science, and as a new entity took over the computer science education. In the old system of higher education the Institute of Informatics successfully managed the computer engineering programs along with the business informatics, engineering informatics, and informatics teacher programs.

The recent restructure of the higher education (Bologna process) was implemented in our Institute, too. In 2005, among the firsts in the Hungarian higher education, we started BSc programs in Computer Science and Business Information Technology, then in 2006 in Engineering Information Technology. We were pioneering in launching Computer Science MSc program in 2007, which were followed with MSc program in Business Information Technology, MA program in Teacher of Informatics in 2008, and Engineering Information Technology MSc program. The Institute of Informatics has had a PhD program since 1993. Gradually we have built up an independent Doctoral School, which is authorized to issue PhD degrees.

The education is conducted in both traditional lecture halls and computerized classrooms or terminal rooms. Our well-equipped classrooms give opportunity to our student to work with the cutting edge computers and softwares. More than 25 high performance server machines provide the necessary computational capacity. In the terminal rooms our students have a wide access to machines.

5. Organization

The head of the Institute: Dr. László Nyúl.

The deputies of the head: Dr. Antal Nagy (general), Dr. Róbert Mingesz (student affairs).

The Institute consists of six departments and a research group which are as follows.

Department of Computational Optimization,

head: Dr. Balázs Bánhelyi

Department of Computer Algorithms and Artificial Intelligence,

head: Prof. Márk Jelasity

Department of Foundations of Computer Science,

head: Dr. Zsolt Gazdag

Department of Image Processing and Computer Graphics,

head: Dr. László Nyúl

Department of Software Engineering,

head: Dr. Rudolf Ferenc

Department of Technical Informatics,

head: Prof. Zoltán Gingl

Research Group on Artificial Intelligence of the Hungarian Academy of Sciences,

head: Prof. Tibor Gyimóthy

In these departments about 50 professors and researchers teach and conduct research.

6. Main courses (by departments):

Department of Computational Optimization

BSc (only in Hungarian): Business Informatics, Introduction to interval analysis, Linear Programming (talent program) level, Linear Programming, Numeric and symbolic calculations, Decision Models.

MSc/PhD: Computational statistics, Logistics and Business Process Modeling, Logistics, Serving Networks, Technical Analysis in the Stock Market, Integrated Corporate Management, Numerical and Symbolic Computing II., Computer Algebra and Scientific Computing, Information Visualization, Nonlinear Programming, Fundamentals of Information Society, Computational statistics, Optimization applications, Mathematical modeling of economic processes, Applications of Linear Programming, Combinatorial optimization, Game Theory, Selected Topics from Operational Research: Positional Games, Graph theory algorithms.

Department of Computer Algorithms and Artificial Intelligence

BSc (only in Hungarian): Algorithms and data structures I., Algorithms and data structures II., Artificial Intelligence I.

MSc/PhD: Informatical systems helping education, Packing and scheduling, Reinforcement Learning, Applied Informatics, Intelligent visualization technologies, Hungarian language processing, Natural language processing and speech recognition, Developing algorithms, Theory of machine learning, Elements of symbolic knowledge representation, Multicriteria decision models, Fuzzy theory, Pattern Recognition, Optimization problems in robotics, String processing methods, Online algorithms, Machine learning, Statistical machine learning, Data Mining.

Department of Foundations of Computer Science

BSc (only in Hungarian): Verification of Hardware and Software Systems, Logic and its applications in informatics, Foundations of Computer Science, Formal languages, Complexity Theory.

MSc/PhD: Automata and formal languages, Tree automata, Theory of Computation, Term Rewrite Systems, Semantics of Programming Languages, Quantum Computing, Process Algebra, Model checking, Finite model theory, Finite Transition Systems, Dynamic Logic, DNA Computing, Cryptography, Automata and Formal Logic.

Department of Image Processing and Computer Graphics

BSc (only in Hungarian): Image Analysis (Talent Care Program), Computer Aided Design, Computer graphics, Elements of computer graphics, Structured Computer Organization, Operating Systems, Introduction to informatics, Digital Image Processing, Introduction into Image Processing, Assembly programming, Introduction to databases, Advanced database systems, Multimedia.

MSc/PhD: Medical Imaging, Geoinformatics, Computer Vision, Operating systems in schools, Image Reconstruction, Image registration, Image databases, Advanced Image Processing, Advanced Computer Graphics, Databases in school, Image segmentation.

Department of Software Engineering

BSc (only in Hungarian): Programming I., Introduction to Programming, Introduction to Programming (talent program), Web Design, Practical Software Quality Assurance, Foundations of Programming, Software Engineering I., Software Engineering II., Software Engineering, Basics of

Object Oriented Programming, Open-source software development, Computer Networks, Application development, Real-time Programming, Programming Languages, Programming II.

MSc/PhD: Advanced Programming, Software maintenance, Network operating systems, Design and development of scalable software systems, Business Web Technologies, Information technologies, Object-Oriented Systems Design, Program Analysis, Testing Methods, Programming Methods, Software Evolution, Compilers, Enterprise information systems, Embedded systems, Functional Programming, Operation systems in schools, Parallel Programming, Programming Languages in Education, Legal, ethical and informatics questions of personal data protection, Software Development.

Department of Technical Informatics

BSc (only in Hungarian): Digital techniques, Electronics, Intelligent systems, Industrial networks, Control and monitoring of industrial processes, Control techniques, Signals and systems, Mechatronics, Measurement and data acquisition, Microcontrollers, Application of microcontrollers, Microcontrollers and peripherals, Modern instrumentation, Robotics.

MSc/PhD: Applications of electronics, Robot programming languages, Virtual instrumentation, Single variable control, Signals and systems, Noise and fluctuations.

7. Education

The institute offers BSc, MSc, MA and PhD degrees. The curricula consist mainly of mandatory courses for undergraduates and a broad spectrum for specialization at graduate level. The curricula have already been adjusted to conform to the so-called Bologna project, embracing most of the topics of modern informatics and computer science. The informatics/computer science and some of the engineering courses belong to the departments of the Institute of Informatics. The Institute of Mathematics and the Faculty of Economics and Business Administration are responsible for the mathematics and economics courses. The physics courses are taught by the Departments of Physics.

BSc PROGRAMS

Presently we have three programs at undergraduate level: Business Information Technology, Engineering Information Technology, and Computer Science. These programs are available in Hungarian only.

Business Information Technology, BSc (in Hungarian)

The normal duration of the program is 7 semesters. The program produces experts who are well versed in the information society, and are able to understand and solve the problems arising in real business processes. They can manage the information technology supporting the business needs, such as to improve on the knowledge base and business intelligence of companies, model the cooperation of information communication processes and technologies, control those processes, identify problems, and develop applications (and also maintain and monitor their quality). Moreover the graduates are equipped by the theoretical basics to continue their studies at MSc level.

Engineering Information Technology, BSc (in Hungarian)

The normal duration of the program is 7 semesters. The goal of the program is to train computer experts with solid engineering skills. The graduates are expected to install and operate complex systems, especially in the information infrastructure area, and also to plan and develop the data and program system of such systems. This means skills both in hardware and advanced software technology, involving modeling, simulation, performance, reliability, configuration, trouble shooting, maintenance, and development of systems. They are also provided with appropriate basic knowledge to continue their studies at MSc level.

Computer Science, BSc (in Hungarian)

The normal duration of the program is 6 semesters. The graduates are supposed to have high skills in planning and development of company information systems using modern software tools. Furthermore, they are trained in the planning, development and operation of decision support systems, expert systems, and multimedia systems. The graduates also receive firm basis in Computer Science knowledge in order to have suitable knowledge to continue their studies at MSc level.

GRADUATE PROGRAMS

Computer Science, MSc (in English and in Hungarian)

The normal duration of the program is 4 semesters. The goal of the training is to produce informatics/computer science experts who have firm theoretical basis, and they are able to expand their knowledge autonomously in a long run. They can work in teams or on their own, to develop, produce, apply, introduce, maintain, and to service information systems at high level. Furthermore, they possess the necessary cooperation and model making skill that are needed for solving of the informatics problems arising in their fields. They are also able to conduct research work, and to continue their studies at PhD level.

Business Information Technology, MSc (in Hungarian)

The normal duration of the program is 4 semesters. The goal of the training is to produce experts who are able to understand complex business processes, to explore the arising problems and work out alternative solutions. They can recognize the surfacing demands that appear while using information systems supporting those processes. They are prepared to develop those and to manage ready-made applications. They possess the necessary skills to coordinate and conduct research and development, and to continue their studies at PhD level.

Teacher of Informatics, MA (in Hungarian)

The normal duration of the program is 4 or 5 semesters, depending on the number of certifications. The program is based on the previous knowledge of the candidates acquired in BSc or MSc level in informatics. The goal of the training is to produce teachers, who can teach various subjects in informatics, and execute tasks arising at schools in connection of training and development of information and communication technology or research. Furthermore the program prepares the students to continue their studies at PhD level.

PhD program in Computer Science (in English and in Hungarian)

In addition to the above programs, a doctoral program in Computer Science is available since 1993. The aim of this program is to support graduate studies, leading to the degree of PhD in computer science. The program had been a part of the Doctoral School in Mathematics and Computer Science of the Faculty of Science of the University of Szeged till the end of 2008, when a new Doctoral School on Computer Science has been founded.

The main research areas in the School: Theoretical Computer Science, Operations Research and Combinatorial Optimization, Software Engineering, Artificial Intelligence, Image Processing, and Electrical and Computer Engineering. The possible research topics preferably, but not exclusively can be chosen among those parts of computer science and related areas, which are being investigated at the Institute of Informatics. The normal duration of the program is 8 semesters. Students are required to take entrance examinations for the admittance. The State of Hungary usually supports up to 6-7 new fellowships every year that is offered to Hungarian citizens. Foreign students are not entitled for that fellowship, their tuition and other expenses have to be supported from other sources such as Stipendium Hungaricum scholarship program.

8. Research

The departments of the Institute conduct research in the following areas.

Department of Computational Optimization

Reliable Computing, Interval Optimization, Discrete Optimization, PNS problems, Extremal Graph Theory, Combinatorial games, Data mining, Network Science, and History of Mathematics.

Department of Computer Algorithms and Artificial Intelligence

Automata theory, Fuzzy theory, Bin packing, Metaheuristics, String matching, On-line algorithms, Machine Learning and Computational Learning Theory, Multi-Criteria Decision Making, Scheduling.

Department of Foundations of Computer Science

Algebra and logics in computer science, Automata and formal languages. Tree-automata and tree-transducers. Term rewriting systems, and fixed points in computer science. Process algebras, Temporal logics. Structures in computer science: semirings and semi-modules, and categorical algebras.

Department of Image Processing and Computer Graphics

Image Models based on Random Markov fields, Parametric estimation of transformations, Higher order active contour models, Analysis of satellite pictures, Digital spatial models. Vectorization of scanned drawings, Computer-Aided surgery. Medical image analysis, Skeletonization by thinning, Image registration, and Discrete tomography.

Department of Software Engineering

Static and dynamic analysis of software systems. Slicing for imperative languages and logical programming. Reverse engineering. Open source software development. Linux file system and GCC compiler optimization. Embedded systems. Ad-Hoc networks. Process synthesis. Optimization problems arising in chemistry, biology and industry.

Department of Technical Informatics

Measurement technology, Instrumentation, Analogue and Digital Electronics, Sensor Signal Conditioning, Signal Processing, Process Control, Robotics, Mechatronics and related hardware and software development.

Research Group on Artificial Intelligence

Machine learning, Computational learning theory. Natural language procession, Language technology, Speech technology, Peer-to-peer algorithms and systems.

9. Miscellanea

ACTA CYBERNETICA

A scientific journal, Acta Cybernetica has been published since 1969 by the Institute in English. It is abstracted by Mathematical Reviews, Computing Reviews, Zentralblatt für Mathematik and ACM Digital Library It is also indexed by Scopus, DBLP, EBSCO and Emerging Sources Citation Index (ESCI). The journal is available in about 150 university departments worldwide, its homepage is: <http://www.inf.u-szeged.hu/kutatas/acta-cybernetica>

OTHER SCIENTIFIC SERVICE

Several members of the faculty work as editors in international scientific journals; they play significant roles in major scientific organizations and serve in program committees of major conferences. Some of those journals:

Acta Cybernetica, Central European Journal of Operations Research, Grammars, IEEE Transactions on Image Processing, Informatica, Pure Mathematics and Application, Theoretical Computer Science, Theoretical Informatics and Applications, Optimization Letters, and Oriental J. of Mathematics.

ORGANIZATIONS IN WHICH THE INSTITUTE IS REPRESENTED

Informatics Europe, European Association for Theoretical Computer Science, European Association for Computer Science Logic, Gesellschaft für Angewandte Mathematik und Mechanik, International Federation of Information Processing, and Association for Computing Machinery.

10. Resources

LIBRARIES

The Institute of Informatics has a library of which holds more than 5000 Hungarian and English volumes and subscribes over 200 scientific journals. The recently renewed University Library also an invaluable resource for both our faculty and our students. It offers not only numerous scientific books, journals but it serves as a place for study and host of conferences. The directories of all libraries at the University are connected together, and their shelved items are searchable by browsers.

HARDWARE/SOFTWARE

The Institute provides computer access for about 3500 users. Students may use 350 workstations, on which both Windows and Linux operating systems are available. All machines are linked to network switches with 1 Gbps, and the Institute's redundant network also has 10 Gbps link to the University Computer Center. The Institute's server park includes: 5 HP ProLiant DL380, 24 HP ProLiant BL460c blade servers connected with 4 TB (MSA 1000) + 12.5 TB (EVA 4000) fiber channel mass storage with regular tape backup. The servers are run by VMware ESXi, Linux and Windows. Several native and virtualized HA clusters provide the services to education, research, and business.

11. Description of Computer Science MSc program

Program coordinator: Zoltán Fülöp full professor, DSc

Level of education: Master's Degree

Profession: Computer Scientist

The place of training: University of Szeged, Hungary

Language of the training: English

The form of study: full-time training

Training time: 4 semesters

The number of required credits: **120** credits

The knowledge material of the training includes:

- Mandatory mathematical and computer science studies, a total of at least **20** credits.
Graph theory (4 credit), Automata and Formal Languages (4 credit), Mathematical Foundations of Logic and Functional Programming (3 credit), On-line algorithms (4 credit), Advanced approximate and symbolic computations (4 credit), Application of Linear Programming (4 credit).
- Elective core studies in mathematics and computer science, a total of at least **3** credits.
Mathematical Foundations of Logic and Functional Programming (3 credit), Artificial Neural Networks and their Applications (3 credit).
- Elective studies in mathematics and computer science, a total of at least **13** credits.
Courses: Analysis (5 credit), Game theory (4 credit), Nonlinear programming (4 credit), Data mining (5 credit), Tree automata (4 credit).
- Mandatory computer science studies, a total of at least **24** credits.
Courses: Advanced programming (5 credit), Advanced image processing (4 credit), Machine learning (6 credit), Advanced graphical algorithms (4 credit), Program systems development (5 credit), Image registration (4 credit), Embedded systems (5 credit), Parallel programming (5 credit), Software development (5 credit), Legal, Ethical and Informatics Issues of Personal Data Protection (3 credit), Network Science (3 credit), Computer Vision (4 credit), Distributed Application Development (5 credit), and occasionally announced special courses (4 credits).
- Elective course (EC): at least **6** credits.
Elective courses which are offered to the specialization by any department of the University of Szeged.
- Thesis work (TW): **30** credits
Courses: Thesis work I (10 credits), Thesis work II. (20 credits)
- Professional training (Internship) of 6 weeks: 0 credits.

The content, theme, structure and evaluation system of the **final exam**:

Conditions to register for the final exam:

- acquired absolutorium (record of transcript),
- submitted thesis.

The final exam consists of two parts:

- an oral examination whose content is made public at least three months before the exam,
- the defense of the thesis.

Topics for the final exam:

A basic knowledge covered by the taught courses in natural sciences, mathematics, computer science and the content of the core courses and the taken courses of the specialization.

The evaluation of the final exam:

The exam committee gives three partial grades:

- the first one is the evaluation of the thesis (TE),
- the second one is for the defense of the thesis (TD),
- the third is the grade of the oral examination on the courses (OE).

The final exam is successful if all partial grades are at least satisfactory.

Evaluation of the **diploma** (DE):

$$DE = (OE + (TE + TD)/2 + CW)/3$$

CW is the credit-weighted average of all courses except the elective course.

The calculated average is turned to grades as follows:

If the average is

- from 4.51 to 5.00: excellent,
- from 3.51 to 4.50: good,
- from 2.51 to 3.50: medium,
- from 2.00 to 2.50: satisfactory.

Awarding the diploma has also language requirement: at least B2-intermediate according to the Common European Framework Reference. The certificate is preferably a state or international language exam (e.g.: TELC B2, ECL B2, TOEFL iBT test score of 72, or PBT score 550; ITP 543, Cambridge First Certificate "B"; IELTS score of at least 5.5).