UNIVERSITY OF DEBRECEN

FACULTY OF INFORMATICS

BSc degree courses
MSc degree courses
PhD courses

Research

Computer Science BSc

Faculty Address: 4028 Debrecen, Kassai út 26.
Correspondence: 4010 Debrecen Pf.: 12
Telephone: +36 52 512 - 900
Fax: +36 52 512-996
E-mail: hivatal@inf.unideb.hu
Web: www.inf.unideb.hu

International Student's Office Address:
4032 Debrecen Egyetem tér 1, Hungary
Correspondence: H-4010 Debrecen P.O. Box 95, Hungary
Phone: +36 52 518 655
Fax: +36 52 518 623
E-mail: englishstudies@detek.unideb.hu
Web: http://englishstudies.sci.unideb.hu

Contents

Foreword by the Dean

Dear Reader,

We are introducing here the Faculty of Informatics at the University of Debrecen. Our faculty is new, having been established in 2004 as a result of a long process of organic growth. The teaching of information technology began in 1972 at the Kossuth Lajos University, one of the predecessors to the University of Debrecen, when 29 students enrolled for studying a particular part of mathematics called software engineering. Today, some of those first students are highly respected instructors at the Faculty. In 1972, the Computer Science Department was established as a sub-division of the Institute of Mathematics, with a teaching staff of seven instructors, later in 1994 the Department of Information Technology.

The pace of change has been breathtaking over the past decades, especially in the field of information technology. The computer has become a common household object. Today, computers and software are not only integral elements of companies' managements and civil administrations, but have become an inseparable part of our everyday lives, and the Internet gives us virtually instantaneous access to an almost limitless pool of information.

The changes undergone by society have not left our University unaffected either. Indeed, they have been one of the driving forces behind our growth. The numbers of IT students, instructors and departments, have been multiplied, and the range of courses we offer has also expanded. At the end of the 1980s, we began providing university-level education in software engineering, IT Teaching and Library IT. We have also played an active role in the founding and running PhD School of Informatics. Today, six departments of the Faculty employ a total of 70 instructors, who are supported in their work by the Dean's Office, the Systems Administration Group and the special library, which is shared with the Institute of Mathematics, Faculty of Natural Science. The Faculty of Informatics currently has more than 2,300 students.

The formation of our Faculty has coincided with implementation of the Bologna process, which has fundamentally determined the direction for future development of higher education in Hungary. We have successfully completed accreditation of the basic specialisations, and in 2004 we were the first institution in Hungary to offer a degree in Software Engineering BSc. In 2005 we launched the System Engineering BSc course, and from 2006 we are running Business Information Management BSc and Library Information Management BSc courses. The curricula of the master's degree courses have also been formulated, with the assistance and cooperation of several other faculties: the Faculty of Economics and Business Administration, the Faculty of Technical Engineering and the Faculty of Sciences. After gaining their master's degrees, our students also have the opportunity to study for their PhD at the PhD School of Informatics, or at Mathematics and Computer Sciences PhD School.

The Faculty of Informatics fulfils an important role with regard to higher education and scientific research in the region. Our instructors have decades of experience in training IT professionals to internationally recognised standard. We consider it a key priority to cooperate with local industry and service providers. We aim to ensure that specialists who graduate from Debrecen do not feel compelled to pursue a career elsewhere, but that as many as possible are able to find employment in the region. To this end we have initiated the Debrecen InfoPark, the "Szilícium Mező" and other important projects like "FUTURE INTERNET", and work as closely as possible with local enterprises.

Sincerely,

Dr. Tamás Mihálydeák, Dean

University of Debrecen

The University of Debrecen, like other integrated institutions of higher education in Hungary, was formed, on 1 January 2000, through the (re)merging of several hitherto autonomous institutions. Its historical roots stretch back to the foundation of the Reformed College of Debrecen (1538), the three academic sections of which later served as the foundation for the Hungarian Royal University of Sciences, created by Statute XXXVI of 1912. This makes the University of Debrecen, with its uninterrupted 450-year history, the oldest institute of higher education in the country to have operated continuously in the same town. Higher education in agriculture began in 1868, when the National Higher School of Agriculture was formed in Debrecen.

With a student body of 30,000 and a 1,700-strong teaching staff, the University of Debrecen is without a doubt one of the largest higher-education institutions in the country, and with its 15 faculties, two independent institutes and 25 doctoral schools (both these figures are highest in the country), it also offers the widest range of educational and research opportunities.

The quality of teaching, and especially of research, is illustrated by the fact that more than half the instructors have a doctorate, and 23 are full or corresponding members of the Hungarian Academy of Sciences. According to the results of the Ministry of Education's annual complex performance report (which serves as the basis for allocating performance-related research funding), the University is the best institution outside of Budapest, and among the top three institutions in the country in terms of research performance, accounting for around 14-15% of the country's overall research volume.

This outstanding centre of academic excellence, with its vast educational and R+D capacity, is an increasingly important factor influencing the economic and social development, and the cultural progress, of the region. It devotes special attention to serving the needs of a knowledge-based economy, and fulfilling the role of a regional knowledge centre. UD is one of the five Hungarian universities that have been awarded the prestigious 'research university' title by the Ministry of Education.

Information: http://www.unideb.hu/portal/en
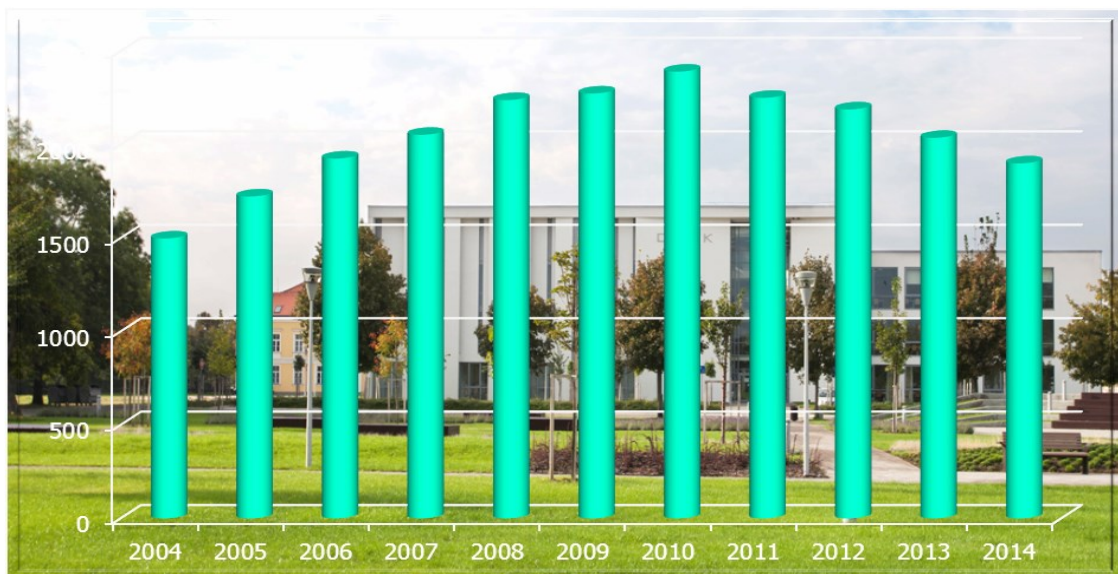
Faculty of Informatics

The **Faculty of Informatics** at the **University of Debrecen** boasts the only accredited university-level educational program for IT specialists in the east-Hungarian region. The six professors, 19 associate professors (senior staff), 29 assistant professors (staff), 16 teaching assistants and 5 graduate computer scientists working at the faculty's seven departments (Department of Applied Mathematics and Probability Theory, Information Technology, Computer Graphics and Image Processing, Library Informatics, Informatics Systems and Networks, Computer Science, Affiliated Department of ICT Systems Operation), represent a formidable pool of intellectual potential, which has earned recognition even at international level.

The aim of the Software Information Technology (Software Engineering), Engineering Information Technology and Business Information Technology majors is to produce IT professionals who possess the complex vocational and theoretical skills needed to scientifically model the practical problems that they will face in the course of their day-to-day work, and to identify and respond to them by selecting or developing the appropriate solutions. Students who graduate from these courses will be capable of supervising teams of specialists assembled for the purpose of performing these tasks, and will possess the basic theoretical, methodological and linguistic skills to conduct research in their chosen field.

The number of students at the faculty increased till 2010. There are currently around 2,000 students studying the specialisations in Hungarian. We started to teach our courses in English in 2007, the number of students is growing year by year.

Number of Students at Faculty of Informatics

Computer equipment at the Faculty

In August of 2011 our Faculty moved to a modern, new building. In this building there are 3 large lecture halls, 8 seminar rooms and 11 well equipped computer laboratories with 195 computers and workstations.

The data network

The building is equipped with a high-speed data network constructed from CAT6a AMP S/FTP cabling with a bandwidth of 10 Gbps. The cables run from 1092 end-points to converge in six rack cabinets. The bulk of data traffic is controlled by 10 Gbit manageable network switches, which are in turn linked via 2*10 Gbps SM connection to a central switch, which connects to the University's backbone at 2*10 Gbit/s.

The building is covered by EDUROAM wireless network, which is servicing the staff and students' requirements.

All computer laboratories are equipped by overhead projectors and we have some mobile projectors too. Some of the machines are connected to peripherals such as multifunctional devices, printers and scanners, to further assist the staff and students in their work. The pool of computer equipment used by staff and students is constantly being improved and upgraded.

Library

The University and National Library University of Debrecen (UNL) was established January 1, 2001 as a result of the university integration with the union of the libraries of the predecessor institutions.

The seven library units of the UNL (see *Libraries*) can be found on the five campuses of the university.

The two main parts of the UNL holdings include the legal deposit collection and the *scientific* collection supporting the educational, research and medical work of the university. The holdings divided among seven research libraries (the Agricultural Science Library, the Arts and Sciences Library, the Kenézy Life Sciences Library, the Engineering Library, the Library of the Faculty of Education, the Social Sciences Library, and the Library of the Conservatory) are available for the employees and students of the University and for the citizens of Debrecen. The collections of the related fields are complemented with valuable special collections.

The largest proportion of the valuable collection of the library (more than 2.700.000 documents) comprises of books and bound periodicals. The digital periodical collection is also significant; with the help of this our users are able to access more than 27.000 periodicals. Above these more than 100.000 music scores, audio files (30.681), images (2874), cartographic materials and other types of documents are available for the users.

Besides the so called traditional services like reading room or circulation the University and National Library provides users with numerous modern services. A major part of the electronic services are available for our users in any part of the world.

The Library collects and manages information on the scientific products of the University of Debrecen. The full texts of the publications are maintained in the University of Debrecen Electronic Archive (DEA).

BSc Degree Courses

Computer Science

Aim of the course:

To train IT professionals who, possessing the solid theoretical grounding necessary to further develop their skills over the long term, are capable of performing, at an advanced level, the typically *software-oriented* development, implementation and servicing tasks related to IT equipment and systems, working either independently or as part of a team. Participants in this course will also learn the interaction and modelling skills required to solve IT tasks in all the main areas of application.

Length of course

- Number of semesters: 6.
- Total hours (total student study time): min. 5,400 hours, of which the number of teaching (contact) hours: min. 1,800.
- Number of credits required to obtain degree: 180.

Language: Hungarian, English

Computer Science Engineering

Aim of the course:

To train IT engineers who have the IT-related skills needed to plan, develop and service technical installations that utilize IT-based solutions, especially with regard to technical IT and IT infrastructure systems and services, as well as their data and software systems, and who have assimilated the practical engineering techniques associated with the installation and commissioning of IT infrastructure.

Length of the course

- Number of semesters: 7
- Total hours (total student study time): min. 6,300 hours, of which the number of teaching (contact) hours: min. 2,100
- Number of credits required to obtain degree: 210

The differentiated compulsory vocational subjects and optional vocational subjects are grouped into specialisations. Students who select a particular specialisation may only obtain the compulsory 40 credits from subjects associated with their chosen specialisation.

Language: Hungarian, English

Specialisations:

Info-communication networks (English)
Measurement and process management
Corporate IT systems

Business Informatics

Aim of the course:

To train IT professionals who are capable of understanding and resolving the specific business processes underlying the information-based society, managing the IT tasks that support value-creating processes, and, making the best use of the opportunities presented by modern information technology in order to increase the knowledge base and business intelligence of organisations, to model processes based on interaction between info-communication processes and technologies, to regulate and plan processes, identify problems, define problem areas, develop and operate applications, and monitor their operation in accordance with the requisite quality standards. Graduates will also posses the depth of theoretical knowledge necessary to continue their training in the second cycle.

Length of the course

- Number of semesters: 7
- Number of teaching (contact) hours: 2,450
- Number of credits required to obtain degree: 210

Language: Hungarian, English

Specialisations:

Corporate management
E-business

Library and Information Science

Aim of the course

The aim of the Library Information Technology course is to train highly qualified specialists with a knowledge of the latest library and information science theory, as well as the skills required for its practical application, including information management and the methodology of research in this field.

Length of course:

- Number of semesters: 6
- Number of credits required to obtain degree: 180
- Number of teaching (contact) hours: 2.250
- Compulsory vocational practice:120 hours after the second semester and 220 hours in the 5-6th semesters.

Language: Hungarian

Specialisation:

Web programmer
Public library

Master's Degree Courses

Computer Science

Aim of the course:

To train IT professionals who, possessing the solid theoretical grounding necessary to further develop their skills over the long term, are capable of performing, at an advanced level, the typically *software-oriented* development, implementation and servicing tasks related to IT equipment and systems, working either independently or as part of a team. Participants in this course will also learn the interaction and modelling skills required to solve IT tasks in all the main areas of applications. Graduates will also posses the depth of theoretical knowledge necessary to continue their studies in PhD Schools.

Length of course:

- Number of semesters: 4
- Total hours (total study time): 3,600, of which the number of contact hours: 1,200.
- Number of credits required to obtain degree: 120

Language: Hungarian, English

Specialisations:

1. Healthcare IT management
2. Information management systems
3. Information systems
4. Image processing and computer graphics
5. Artificial intelligence
6. Computer science

Business Informatics

Aim of the course:

To train IT professionals who are capable of understanding and resolving the specific business processes underlying the information-based society, managing the IT tasks that support value-creating processes, and, making the best use of the opportunities presented by modern information technology in order to increase the knowledge base and business intelligence of organisations, to model processes based on interaction between info-communication processes and technologies, to regulate and plan processes, identify problems, define problem areas, develop and operate applications, and monitor their operation in accordance with the requisite quality standards. Graduates will also posses the depth of theoretical knowledge necessary to continue their training in PhD Schools.

Length of the course

- Number of semesters: 4
- Total hours (total study time): 3,600, of which the number of contact hours: 1,200.
- Number of credits required to obtain degree: 120
Language: Hungarian

Specialisations:

- Informatics for Business Administration
- Economic Modelling
- Informatics for Public Sector
- Informatics for Rural Development

Computer Science Engineering

Aim of the course:

To train IT engineers who have the IT-related skills needed to plan, develop and service technical installations that utilize IT-based solutions, especially with regard to technical IT and IT infrastructure systems and services, as well as their data and software systems, and who have assimilated the practical engineering techniques associated with the installation and commissioning of IT infrastructure.

Length of the course

- Number of semesters: 4
- Total hours (total student study time): min. 3,600 hours, of which the number of teaching (contact) hours: min. 1,200
- Number of credits required to obtain degree: 120

The differentiated compulsory vocational subjects and optional vocational subjects are grouped into specialisations. Students who select a particular specialisation may only obtain the compulsory 40 credits from subjects associated with their chosen specialisation.

Language: Hungarian

Specialisations:

> Info-communication networks (English)
> Hardware programming

Library Information Sciences

Aim of the course

The aim of the Library Information Technology course is to train highly qualified specialists with a knowledge of the latest library and information science theory, as well as the skills required for its practical application, including information management and the methodology of research in this field.

Length of course:

- Number of semesters: 4
- Number of credits required to obtain degree: 120
- Number of teaching (contact) hours: 1200

Language: Hungarian

13

Teacher – Teacher of Informatics
Course in Hungarian

Teacher – Teacher of Library-pedagogy
Course in Hungarian

PhD School of Informatics

Head of the School: Dr. Attila Pethő, DSc, full professor

Programs:

- Discrete mathematics, image processing and computer graphics (Director: Prof. András Kruppa)
- Theoretical basis and applications of the information technology and the stochastic systems (Director: Prof. István Fazekas)
- Theoretical computer science, data security and cryptography (Director: Prof. Attila Pethő)
- Information technology systems and networks (Director: Prof. János Sztrik)
- Applied IT and its theoretical background (Director: Prof. György Terdik)
- Industrial and scientific applications of the informatics (Director: Prof. Gábor Halász)

 Length of the program: 6 semesters

The staff of the IT Faculty also plays an important part in the work of the Mathematics and Computer Science PhD School, which runs 9 programs.

CISCO Regional Academy

Computer networks appeared 20 years ago as a standalone and well separated topic of computer science studies. After some years of teaching networking it could be discovered, that the theoretical and practical topics covered in the "Computer networks" course are not fully adequate and not specialized to the workplace market requests. At this point (in 1999) the Cisco Networking Academy Program appeared in Hungary, and it was recognized, that introducing the CNAP into the teaching would help the students in solving computer networking problems, so their knowledge will be much more closer and adequate to the workplace market requests. University of Debrecen was the first university in Hungary, who joined to the Cisco Networking Academy Program as a Regional Academy in 1999.

Following the so called "Bologna' Process" structure, two levels (Batchelor and Master level) higher education appeared in the computer science teaching, too. In 2004 the bachelor courses of "Computer Engineering" were accredited and started at the Faculty. The Computer Engineering contains three kind of specialization direction, including the "Communication technologies". The CCNA courses are offered for the students of the "Communication technologies" direction as a "direction mandatory course". The CCNA courses take high number of lectures, practical and labor studies: two semesters, 120 hours per semester. Usually there are two groups for full-time students (10-16 students per group), and one group for part-time students. The clear aim of the CCNA courses is to get theoretically and practically strong and deep internationally accepted level of networking knowledge for the students.

The most important and most interesting parts of the CCNA courses are the practical and labor lessons. The study catalogs show, that almost 100 percent of the students are present on all of the labors. Students work in a team to solve different configuration and error detection/correction labor tasks during the semester. We recognized the high students' interest for the laboratory work, and also it was clear to see, that the equipment (router and switch) usage of the Cisco laboratory is very low (only 30-40 hours per week). In order to

solve this "bottleneck problem", a software system was developed, which opened the possibility for the students to use the equipments of the Cisco laboratory from home (according to a well prepared scheduling). The remote access system works perfectly since 2005, and it has duplicated the usage ratio of our laboratory equipments.

Each student must solve a quite complicated practical exam at the end of the semesters (applying a 3 hours time limit), which needs very strong and deep knowledge both on the theoretical and practical fields. As a result, 50-60 percent of the students successfully pass the international VUE CCNA (640-802) exam for the first trial. This ratio is one of the highest in the Hungarian Cisco Academies, but it is very high in the international context too.

The faculty would like to increase further the networking knowledge of the informatics professional students, so a CCNP teaching environment was established (certified instructors, equipments, etc.), and the CCNP courses for students were started in February of 2010.

In 2009 the Faculty of Informatics University of Debrecen won the "Academy of Excellence" award (the winning process of this award is based on objective measurement numbers/facts of the last years' performance; actually only two universities were able to reach this level).

CNAP technical background: More than 20 Cisco routers dedicated for the CNAP laboratory (mainly of type 28xx); more than 10 Cisco switches dedicated for the CNAP laboratory (mainly of type 2960).
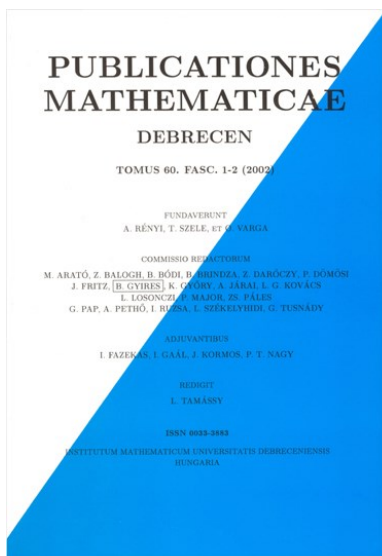
Research

The scientific research conducted at the Faculty of Informatics has steadily broadened in scope and increased in depth over the past decades. Our international reputation for excellence has been further strengthened by the work of our leading scientists in the following areas: stochastic processes and modelling, multivariable statistics, time line analysis, business mathematics, queuing and mass service theory, numerical mathematics, operation research, system theory, databases and information systems, system management, software technology, computer graphics, computerised image processing, form recognition, efficiency studies, quality assurance, code theory, decision theory, computerised text processing and linguistics., formal languages and systems, artificial intelligence, computational number theory, computer algebra, cryptography, statistical inference of stochastip processes and rendom fields applications of statistics.

Besides the considerable financial contribution made by the Faculty itself, the OTKA, FEFA, OMFB, TEMPUS and other (NKFP, IKTA) subsidies that have been awarded continuously since 1986 play a key role in funding the research.

A number of successful research and development projects have already been based on intensive international cooperation, closely related to specific areas of application. The researchers working on these projects are always prepared to cooperate with local and international partners in order to achieve further results and develop new dedicated applications. Besides the unwavering commitment of the senior staff, the following factors are also highly conducive to the formation of cooperative partnerships of this nature:

- the specialist library, containing more the 25,000 volumes, run jointly with the Institute of Mathematics
- the well-structured institutional LAN, which links around 300 personal computers and contains several hardware and software platforms (Sun Sparc, INTEL, RS6000, Unix, Microsoft, Novell), and which is connected to the internet via a high-speed datalink
- the research team's wealth of experience in international projects, cooperation, and project management
- the involvement of high numbers of outstandingly capable information technology students in the actual (software) development work, through the formation of development teams headed by talented young members of staff.

Periodicals

Publicationes Mathematicae Debrecen

The journal appears quarterly and publishes original research papers on pure mathematical topics. It welcomes contributed papers that develop interesting, or important, new mathematical ideas and results or solve outstanding problems. All papers are refereed for correctness and suitability for publication. Publicationes Mathematicae Debrecen is covered by the Mathematical Reviews, the Zentralblatt der Mathematik, the Science Abstracts and the Science Citation Index.

Teaching Matematics and Computer Science

The aim of this journal is to publish high quality papers on teaching and education in two fields: Mathematics and Computer Science. Papers are expected to deal with issues related to classroom activities or any other aspect of educational work in one of these fields. Contributions can be concerned with problems relevant to all types of schools, running from elementary schools to universities. Papers should be written mainly in English, but also in French or German, with an abstract in English.
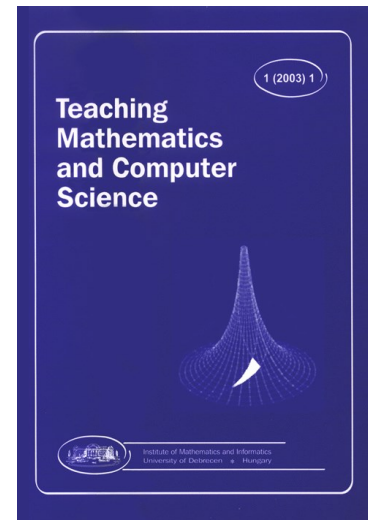
The Béla Gyires IT Lectures

Béla Gyires (1909-2001) was a key personality at the Mathematics and Information Technology Institute of the Kossuth Lajos University of Science, which was a predecessor to the University of Debrecen. For many years he was director of the institute. He founded, and headed for 30 years, the Department of Probability Calculation and Applied Mathematics. It was under his direction that the Computing Centre was formed in 1967. He was instrumental in ensuring that subjects as important and modern as probability calculation, mathematical statistics, computer science and information technology were incorporated into the university's curriculum. In 1972, it was at his instigation and under his direction that the courses in Programming Mathematics were introduced. He was the highly regarded a... ...ations of mathematics students.

In his honour, the Béla Gyires IT Lectures are held once a year. At the event, each department of the Faculty gives a presentation of its research activities, in the form of a scientific lecture.

Departments

Department of Applied Mathematics and Probability Theory

Head of Department: Dr. habil István Fazekas, Full professor

Email: fazekas.istvan@inf.unideb.hu
www: http://w1.inf.unideb.hu/en/web/alkalmazott-matematika-es-valoszinusegszamitas-tanszek/home

Research fields

- Probability theory
- Mathematical statistics
- Operation research
- Numerical mathematics
- JAVA technology
- Statistical inference of stochastic processes and rendom fields
- Applications of statistics.

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Department of Informatics Systems and Networks

Head of Department: Dr. János Sztrik, Full professor

Email: sztrik.janos@inf.unideb.hu
www: http://w1.inf.unideb.hu/web/informatikai-rendszerek-es-halozatok-tanszek

Research fields

- Performance evaluation of information systems
- Queueing systems
- Stochastic modeling of computer architectures and networks
- Reliability investigation of complex systems
- Stochastic simulation

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Department of Information Technology

Head of Department: Dr. habil Márton Ispány, Associate professor

Email: ispany.marton@inf.unideb.hu
www: http://w1.inf.unideb.hu/en/web/informacio-technologia-tanszek/home

Research fields

- Mathematical models and statistical studies of systems
- Combinatorial coding theory
- Pattern recognition, image processing, discrete mathematical methods and their application
- Object-oriented technologies and beyond, database systems, web modelling, software analysis
- Quantum chemistry and atom physics calculations
- Computer-aided applied linguistic research
- Didactic questions related to the teaching of information science
- Other developments and applications

Department of Computer Science

Head of Department: Dr. habil György Vaszil Associate professor

Email: vaszil.gyorgy@inf.unideb.hu
www: http://w1.inf.unideb.hu/en/web/szamitogeptudomanyi-tanszek/home

Research fields

- Mathematical logic, modal and intensional logic, type-theory logic, partial logic, formal semantics, temporal logic, logical philosophy, automated theorem proving
- Operation research
- Artificial intelligence, expert systems, knowledge depiction, descriptive logics
- Formal languages and automatons
- Multi-modal man-machine relationship, skeletonization algorithms, Support Vector Machine, face recognition, neighborhood sequences
- Neighborhood sequences, digital geometry
- Linear recursive sequences, random number generators
- Cryptography, computer algebra

Department of the Computer Graphics and Image Processing

Head of Department: Dr. habil András Hajdu Associate professor

Email: hajdu.andras@inf.unideb.hu
www: http://w1.inf.unideb.hu/en/web/komputergrafika-es-kepfeldolgozas-tanszek/home

Research fields

- Linear mappings
- Descriptive geometry, cyclographic mapping, central-axonomerty
- Application of artifical neural networks in computer graphics
- Free-form modelling
- Geometric correction of digital images
- Applied mathemathical methods in dentistry

Department of Library Informatics

Head of Department: Dr. habil Attila Gilányi, Associate professor

Email: gilanyi.attila@inf.unideb.hu
www: http://w1.inf.unideb.hu/en/web/konyvtarinformatika-tanszek/

Research fields

- Information Supply for Teachers
- Project-based Learning Processes
- New trends in Library Education
- Hypertext and Hypermedia Applications
- Using Concordances in the Interpretation of Library Texts
- Automated Libraries
- Integrated Library Information Systems
- MARC Standards, New Medias and Electronic Documents
- Formats of International Data Exchange
- Electronic Libraries

Affiliated Department of ICT Systems Operation

Head of Department: András Harman

Email: Andras.Harman@t-systems.com
www: http://www.it-services.hu/?lang=en

Computer Science BSc

<u>Aim of the program</u>

To train IT professionals possessing a firm theoretical background, who are capable of performing, at an advanced level, the typically software-oriented development, implementation and servicing tasks related to IT equipment and systems, working either independently or as part of a team. Participants in this course will also learn the interaction and modeling skills required to solve IT tasks in all the main areas of application.

<u>Length of the program</u>

- Number of semesters: 6.
- Total hours (total student study time): min. 5,400 hours, of which the number of teaching (contact) hours: min. 1,800.
- Number of credits required to obtain degree: 180.

	Credits
Natural Science and basic vocational training	120
Compulsory vocational subjects of choice	29
Optional natural science subjects	5
Other optional subjects	6
Thesis	20

The grade of diplom will be calculated from the final grade for the state exam and the grade of the next subjects:

- o INGK302 Programming Languages 2
- o INGK212 Operating Systems 2
- o INGK501 Database Systems

The compulsory vocational subjects of choice are divided into five modules named A, B, C, D, S. At least one subject from each modul should be chosen and in total 29 credits from the modul subjects should be collected.

Natural science and basic vocational training subjects

Code	Subject	Credit	Hrs per week			Exam	Prere-quisites	Period	Semester
			L	Practice					
				S	Lab				
INGK101E INGK101G	Discrete Mathematics 1	5 0	2	2		E S	INGK101G*	1	1
INGK111E INGK111G	Calculus 1	5 0	2	2		E S	INGK111G*	1	1

Code	Subject	Credit	Hrs per week			Exam	Pre-requisites	Period	Semester
			L	S	Lab				
INGK401E INGK401G	Logic in Computer Science	50	2	2		E S	INGK401G*	1	1
INGK201E INGK201L	Introduction to Informatics	50	2		2	E S	INGK201L*	1	1
INGK202L	HTML, XML	2			2	P		1	1
INGK711E INGK711L	Computer Architectures	50	2		2	E S	INGK711L*	1	1
INGK102E INGK102G	Discrete Mathematics 2	50	2	2		E S	INGK101E, INGK102G*	2	2
INGK112E INGK112G	Calculus 2	50	2	2		E S	INGK111E, INGK112G*	2	2
INGK131E INGK131L	Probability Theory and Statistics	50	2		2	E S	INGK101E, INGK111E, INGK131L*	2	2
INGK421E INGK421G	Data Structures and Algorythms	50	2	2		E S	INGK201E, INGK421G*	2	2
INGK301E INGK301L	Programming Languages 1	50	2		2	E S	INGK201E, INGK301L*	2	2
INGK211E INGK211L	Operating Systems 1	50	2		2	E S	INGK201E, INGK211L*	2	2
INGK411E INGK411G	Automats and Formal Languages	50	2	2		E S	INGK101E, INGK411G*	1	3
INGK302E INGK302L	Programming Languages 2	50	2		2	E S	INGK301E, INGK302L*	1	3
INGK212E INGK212L	Operating Systems 2	50	2		2	E S	INGK211E, INGK212L*	1	3
INGK501E INGK501L	Database Systems	50	2		2	E S	INGK301E, INGK501L*	1	3
INGK601E INGK601L	Introduction to Computer Graphics	50	2		2	E S	INGK101E, INGK301E, INGK601L*	1	3
INGK141E INGK141L	Numerical Methods	50	2		2	E S	INGK102E, INGK141L*	2	4
INGK441E INGK441G	Introduction to Artificial Intelligence	50	2	2		E S	INGK302E or (INGK301E and INGK401E) INGK441G*	2	4
INGK311L	Programming Environments	2			2	P	INGK302E	2	4
INGK321E INGK321L	Programming Technologies	50	2		2	E S	INGK302E, INGK321L*	2	4
INGK721E INGK721L	Computer Networks and Protocols	50	2		2	E S	INGK711E, INGK212E, INGK721L*	2	4

Code	Subject	Credit	Hrs per week			Exam	Prere-quisites	Period	Semester
			L	Practice					
				S	Lab				
INGK511E	Database Administration	3	2			E	INGK501E	1	5
INGK521E INGK521L	Technology of System Development	5 0	2		2	E S	INGK321E, INGK521L*	1	5
INGS001X	Thesis 1	10		0		P	INGK321E	F	5
INGK451E INGK451G	Developing and Analyzing Algorythms	5 0	2	2		E S	INGK401E, INGK411E, INGK451G*	2	6
INGK231E	Internet Tools and Services	3	2			E	INGK521E	2	6
INGS002X	Thesis 2	10		0		P	INGK321E	F	6

Compulsory optional subjects

Code	Subject	Credit	Hrs per week			Exam	Prere-quisites	Period	Modul
			L	Practice					
				S	Lab				
INGV442E INGV442L	Programming Languages of Artificial Intelligence	5 0	2		2	E S	INGK401E, INGK441E, INGV442L*	I	A
INGV443E INGV443L	Knowledge-based Systems	5 0	2		2	E S	INGK441E, INGV443L*	I	A
INGV444E INGV444L	Some Aspects of Artificial Intelligence	3	2			E	INGK441E	I	A
INGV221E INGV221L	Compilers	5 0	2		2	E S	INGK411E, INGK302E, INGK221L*	I	A
INGV502E	Database System Implementation 1	3	2			E	INGK501E	I	B
INGV503E	Database System Implementation 2	3	2			E	INGV502E	I	B
INGV531E INGV531L	Advanced DBMS 1	5 0	2		2	E S	INGK501E, INGV531L*	I	B
INGV532E INGV532L	Advanced DBMS 2	5 0	2		2	E S	INGV531E, INGV532L*	I	B
INGV702L	Server Administration	3			2	P	INGK721E	I	C

Code	Subject	Credit	Hrs per week			Exam	Prere-quisites	Period	Modul
			L	Practice					
				S	Lab				
INGV722E	High-Speed Local and Metropolitan Area Networks	3	2			E	INGK721E	I	C
INGV723E	Actual Problems of Voice and Data Communication	3	2			E	INGK721E	I	C
INGV724E INGV724L	Performance Evaluation of Networks	5 0	2		2	E S	INGK131E, INGV724L*	I	C
INGV602E INGV602L	Computer Graphics	5 0	2		2	E S	INGK601E, INGV602L*	I	D
INGV603E INGV603L	Graphical Systems	5 0	2		2	E S	INGV602E, INGV603L*	I	D
INGV611L	GIS	3			2	P	INGK601E	I	D
INGV621E INGV621L	Multimedia	5 0	2		2	E S	INGK601E, INGV621L*	I	D
INGV122E	Information Theory	3	2			E	INGK131E	I	S
INGV123E INGV123L	Neural Networks	5 0	2		2	E S	INGK131E, INGV123L*	I	S
INGV132E INGV132L	Computer Statistics	5 0	2		2	E S	INGK131E, INGV132L*	I	S
INGV151E INGV151L	Operation Research	5 0	2		2	E S	INGK141E, INGV151L*	I	S

Exam types: E – exam
             S – sign
             P – practical

 * subjects are parallel

Description of subjects

DISCRETE MATHEMATICS 1
INGK101

Topics:
Sets, set algebra, relations, functions. Equivalence and ordering. Synthesis of number concept.

Natural numbers, operations, sorting, mathematical induction. Integers, rational numbers, real numbers, cardinality. Complex numbers, its canonic, trigonometric and exponential forms, nth root, roots of unity. Irrational, algebric and transcendental numbers.

Fundamental theorem of algebra and its consequence. Polynoms, rational fractional functions, method of partial fractions.

Elements of combinatorics. Enumerative basic exercises: permutations, combinations and variations without and with repetition. Binomial theorem, polynomial theorem. Cardinality of finite sets' union, intersection and complements of intersections (sieve theory). Partition problems. Generator function.

Finite-dimensional vector spaces, subspace, linear independence, basis, dimension,. Matrix algebra; invertibility of matrices, rank. Properties of determinants, formula to expand the determinant along a row or column, theory of product matrix product theorem. Solvability assumptions of homogeneous and inhomogeneous systems of linear equations, characterization solution set, determining of general solution.

Compulsory/Recommended Readings:
- Agnew, J. – Knapp, R.C.: Linear Algebra with Applications. Brooks/Cole Publ. Co., Monterey, California, 1978.
- Birkhoff, G. – MacLane, S.: A Survey of Modern Algebra. 3rd Edition, MacMillan Company, 1965.
- Davis, P.J.: The Mathematics of Matrices. Blaisdell Publ. Co., London, 1965.
- Kaner, P.: Integrated Mathematics Scheme. IMSN1. Bell & Hyman, London, 1984.
- Lang, S.: Linear Algebra. 2nd Edition. Addison-Wesley Publ. Co., 1971.
- Schreier, O. – Sperner, E.: Introduction to Modern Algebra and Matrix Theory. 2nd Edition, Chelsea, 1959.
- Tucker, A.: Applied Combinatorics. (2nd Edition), John Wiley and Sons, New York, 1984.

CALCULUS 1
INGK111

Topics:
Sequences, properties and convergence. Cauchy's convergence criterion. Real functions and their inverses, composite functions, elementary functions. Limit and continuity of functions. Properties of continuous functions. Differentiability of real

functions, calculus rules. Mean value theorems. Taylor's formula. Graphing and discussing functions. Extremal values. Local and global properties of functions. Series, convergence, absolute convergence, convergence criteria. Series of positive terms, reordering.

Compulsory/Recommended Readings:
- Binmore, K.G.: Mathematical Analysis. A straightforward approach. Cambridge, 1989.
- Kaner, P.: Integrated Mathematics Scheme. IMSN1. Bell & Hyman, London, 1984.
- Lang, S.: Undergraduate Analysis. [Undergraduate Texts in Mathematics.] Springer, New York – Berlin – Heidelberg – Tokyo, 1983. ISBN 0-387-90800-5.

LOGIC IN COMPUTER SCIENCE
INGK401

Topics:
The language of first-order-logic, terms, formulas. Free variables and bounded variables, bounded variables renaming, quantifier-free formula. Term substitution. Interpretations, truth assignments. Satisfiability, logically valid formulas and not-valid formulas. Logical equivalent. Conjunctive and disjunctive normal forms, prenex normal forms, Skolem normal form. Logical consequences. Predicate calculus, theory of deduction, rules of natural derivation. Proof theory. First order theories.

Compulsory/Recommended Readings:
- Elliot Mendelson: Introduction to Mathematical Logic, Chapman&Hall, 1994.
- Joseph R. Shoenfield: Matematical Logic, AK Peters, 1991.
- S. Abramsky, Dov M. Gabbay, T. S. E. Maibau: Handbook of Logic in Computer Science, Oxford University Press, 1992.

INTRODUCTION TO INFORMATICS
INGK201

Topics:
Computer as information processing machine. Comuter architectures. Basic terminology of informatics (data, program, compiler, interpreter, programming, operating system, software, system software, application software, bit, byte, compatibility, syntax, semantics, programming languages, spreadsheet programs, text editors, database management systems). Types and use of peripheral devices. Concept of operating systems. Algorithms. Scales, convension of conversion. Computer information representation (address, logical, string and numerical data, operations and programs). Basics of computer processors. Programming computers. Programming in Machine code. Assembly and high level programming languages. Basic algorithms (ordering, searching, picking). Network basics. Steps of information system development.

Compulsory/Recommended Readings:
- J. G. Brookshear: Computer Science: An Overview, Seventh edition. Addison Wesley, 2003.
- L. Snyder: Fluency with Information Technology: Skills, Concepts, and Capabilities. Addison Wesley, 2004.

COMPUTER ARCHITECTURES
INGK711

Topics:
Computer generations, the internal architecture of a computer: storage, control unit, processor, I/O system, channel, system bus. General microprocessor model. Logical operations and values, logical functions. Graphic minimization, Weitch- Karnaugh tableau. Simple combination logical networks: multiplexer, demultiplexer, entcoder, decoder, code converters, comparers, parity check units, summation units. Hazards at logical circuits. Basic ordering units: RS flip-flop, JK flip-flop, T flip- flop, D flip-flop. Multivibrators, registers. Synchronized and asynchronized counters. Semiconductor memories: classification and operation principles. Classification and implementation of machine level commands, memory and I/O cycles. Machine level control transfer, processor controlled and independent states. The I/O system. AD and DA converters, serial and parallel adapters. Character oriented and graphic picture presentation. Pheripheries: keyboards, mouse, scanners, printers. Secondary storages: fixed disks, tapes, optical storages. Computer classification: SISD,
SIMD, MISD, MIMD, RISC, CISC computers. Transputers. Parallelism, super scalar architecture, multiprocessor systems, vector computers. Dataflow computers.

Compulsory/Recommended Readings:
- Patterson D.A., Henessy J.L.: Computer organization & Design, Morgan Kaufmannn Publ. (2 ed.) 1998.
- Rob Williams: Computer System Architecture (A Networking Approach), Addison Wesley, 2001.

AUTOMATS AND FORMAL LANGUAGES
INGK411

Topics:
Main types of formal systems and automata. Languages and grammars, normal forms. Formal languages and automata. Chomsky hierarchy. Operations on languages. Grammatical algorithms, parsing. Lindenmayer systems. Kleene theorem, Bar-Hillel lemma, Early algorithm, Lyon algorithm. Applications in computer science.

Compulsory/Recommended Readings:
- Hopcroft, J. E. and Ullmann, J. D.: Introduction to Automata Theory, Languages,and Computation. Addison-Wesley, 1979.
- Salomaa, A: Formal languages, 1973.

DISCRETE MATHEMATICS 2
INGK102

Topics:

Linear mappings of finite dimensional vector spaces; properties of mapping, matrix representation. Scalar product. Cauchy-Schwarz inequality. Ortogonality, norm. Self-adjoined and unitary matrices. Characteristic root, characteristic vector, invariant subspaces. Jordan normal form of matrices. Quadratic forms, canonical form.

Combinatorical probability. Total probability, Bayes's theorem. Discrete distributions. Expected value, standard deviation. Law of large numbers.

Elements of mathematical statistics. Mean, standard deviation; usage of tables.

Fundamentals of graph theory. Graphs, oriented graphs, matrix representation, routes, cycles, special graphs and their properties.

Fundamentals of coding theory. Dissolvable, prefix codes. Optimal code, entropy, information. Huffmann code. Hamming distance, error-correcting code, decoding methods. Linear codes.

Compulsory/Recommended Readings:
- Agnew, J. – Knapp, R.C.: Linear Algebra with Applications. Brooks/Cole Publ. Co., Monterey, California, 1978.
- Birkhoff, G. – MacLane, S.: A Survey of Modern Algebra. 3rd Edition, MacMillan Company, 1965.
- Davis, P.J.: The Mathematics of Matrices. Blaisdell Publ. Co., London, 1965.
- Kaner, P.: Integrated Mathematics Scheme. IMSN1. Bell & Hyman, London, 1984.
- Lang, S.: Linear Algebra. 2nd Edition. Addison-Wesley Publ. Co., 1971.
- Lang, S.: Algebra. Addison-Wesley, Reading – London, 1969.
- Schreier, O. – Sperner, E.: Introduction to Modern Algebra and Matrix Theory. 2nd Edition, Chelsea, 1959.
- Tucker, A.: Applied Combinatorics. (2nd Edition), John Wiley and Sons, New York, 1984.

CALCULUS 2
INGK112

Topics:

Notion of Riemann integral, integration of elementary functions. Primitive functions, integration methods. Mean value theorems. Riemann-Stieltjes integral and its properties. Notion of measure (computation of arc length, area, volume, and surface). Improper integrals.

Ordinary differential equations. Elementary solution methods of first-order differential equations. Higher-order differential equations of constant coefficients. Linear homogeneous and inhomogeneous second-order differential equations.

Vector valued functions of several variables. Metrics and norm. Continuity of functions of several variables. Differentiability, partial differentiability, directional differentiability, gradient, composite functions. Mean value theorem, Taylor's theorem

for functions of several variables. Extremal values. Implicit and inverse function theorems. Multiple Riemann integral, computation, and applications. Integral transformations and their applications.

Sequences and series of functions. Power series. Operations with function series.

Compulsory/Recommended Readings:
- Binmore, K.G.: Mathematical Analysis. A straightforward approach. Cambridge, 1989.
- Kaner, P.: Integrated Mathematics Scheme. IMSN1. Bell & Hyman, London, 1984.
- Lang, S.: Undergraduate Analysis. [Undergraduate Texts in Mathematics.] Springer, New York – Berlin – Heidelberg – Tokyo, 1983. ISBN 0-387-90800-5.
- Rudin, W.: Principles of Mathematical Analysis. 3rd Edition, 1976. McGraw-Hill International Editions. Printed in Singapore. ISBN 0-07-054235-X.

DATA STRUCTURES AND ALGORYTHMS
INGK421

Topics:
Concept and classification of data structures. Operations on data structures (create, add, delete, change, search, traverse, process). Representation and implementation and usage of data structures. Abstract data structures. Set, multi-set, array, associative array, list, stack, queue, string, tree, balanced tree, red-black tree, B-tree, net, record. File operations (create, modify, process, reorganize, sort.) File structures (simple and complex), linking, indexing. Serial, sequential, direct, random, indexed, inverted, multi-list, B+-tree files. Multi-dimensional index.

Compulsory/Recommended Readings:
- G. Gonnet, R. Baeza-Yates: Handbook of algorithms and data structures. In Pascal and C., Addison-Wesley. 1991.
- R. Sedgewick: Algoritms in C++, Addison-Wesley. 1991.
- E. Horowitz, S. Shani: Fundamentals of Computer Algorithms, Computer Science Press, 1998.

PROGRAMMING LANGUAGES 1
INGK301

Topics:
History of programming languages. Classification of programming languages: imperative (procedural and object oriented), declarative (functional and logic), special and alternative languages. Specifying syntax. Character set. Lexical elements (symbolic names, comment, label, literals). Named constant, variable. Data types (predefined and programmer defined, scalar and structured). Declaration. Expressions. Statements. Assignment, jump, selection, iteration. Program units (subprogram, block, package, task). Parameter evaluation, parameter passing.

Scope and life time. Compilation unit. Input-output, files. Abstract data type. Exception handling. Generic programming. Parallel programming.

Compulsory/Recommended Readings:
- R.W. Sebesta, Concepts of Programming Languages. Addison-Wesley, 2006.
- M. L. Scott, Programming Language Pragmatics. Morgan Kaufmann, 2000.

OPERATING SYSTEMS 1
INGK211

Topics:
The hierarchical structure of computer systems, the notion and role of operating system. Basic hardware notions concerning operating systems: processors, main memories, storages, other peripheries, interrupt system. The evolution of operating systems.
Operation systems components and services: system management (CPU scheduling, interrupt handling, process synchronization, process control, memory management, storage management, data (file) management, network access management, protection subsystem, logging and accounting, operator interface); program development support (syntax oriented text editors, compilers, interpreters, linkage editors, loaders, library handlers, debuggers, IDE-s, runtime systems); application support (command line subsystem, GUI, system services, application packages);
Practical Class topics: the above problems focused on a practically known and accepted OS (Win. NT, Unix/Linux/Solaris).

Compulsory/Recommended Readings:
- Silberschatz, Abraham, Operating system concepts, Addison-Wesley, c1994, xvi, 780 p. : ill. ; 25 cm, ISBN 0 201 59292 4
- Nutt, Gary J., Operating systems : a modern perspective, Addison-Wesley, 1997. - XXII, 630 S. , ISBN 0-8053-1295-1
- William Stallings: Operating systems (Internals and design principles), Prentice Hall (4. ed.) 2001.

PROBABILITY THEORY AND STATISTICS
INGK131

Topics:
Intuitive notion of probability based on relative frequency. Algebra of events. Probability space. Combinatorical probability theory. Conditional probability, independence. Chain rule, formula of total probability, Bayes formula. Discrete random variables, independence, expectation, variance. Binomial, hipergeometric, negative binomial and Poisson distributions. Distribution function, density function, and the general notion of expectation and variance.
Uniform, exponential and normal distributions. Joint distribution function, joint density function, independence. Correlation coefficient. Laws of large numbers and the central limit theorem.

Compulsory/Recommended Readings:
- Feller, William: An introduction to probability theory and its applications. Vol. I. Third edition John Wiley & Sons, Inc., New York-London-Sydney 1968 xviii+509 pp.
- Feller, William: An introduction to probability theory and its applications. Vol. II. Second edition John Wiley & Sons, Inc., New York-London-Sydney 1971
  xxiv
- Graham, Ronald L.; Knuth, Donald E.; Patashnik, Oren: Concrete mathematics. A foundation for computer science. Second edition. Addison-Wesley Publishing Company, Reading, MA, 1994. xiv+657 pp. ISBN: 0-201-55802-5+669 pp.

COMPUTER STATISTICS
INGV132

Topics:
Statistical variable, sample, sampling methods. Measuring scales. Empirical distribution function. Empirical mean, empirical variance. Generating probability distributions. Data analysis: descriptive statistics and graphical methods. Estimators and confidence intervals. Testing hypotheses. Parametric tests: u-, t-, F-, and chi-square tests. Nonparametric tests: chi-square, sign, Wilcoxon, and Mann-Whitney tests. Testing normality. Linear regression. Analysis of variance. At practice the application of a statistical package for case studies.

Compulsory/Recommended Readings:
- Williams, D. Weighing the odds. A course in probability and statistics. Cambridge University Press, Cambridge, 2001.
- Stoodley, K.D.C. – Lewis, T. – Stainton, C.L.S.: Applied Statistical Techniques. Ellis Horwood, Chichester, 1980.
- Lange, K.: Numerical Analysis for Statisticians. Springer. New York, 1998.

PROGRAMMING LANGUAGES 2
INGK302

Topics:
The object oriented paradigm: class, object, encapsulation, visibility, inheritance, polymorphism, early and late binding, messages. Classification of object oriented programming languages. Imperative object oriented programming languages (Java, C#, Eiffel, Smalltalk). The functional paradigm. First-class function values and higher-order functions, recursion, structured functions. LISP, CLOS. The logic paradigm. Prolog.

Compulsory/Recommended Readings:
- R.W. Sebesta, Concepts of Programming Languages. Addison-Wesley, 2006.
- M. L. Scott, Programming Language Pragmatics. Morgan Kaufmann, 2000.

DATABASE SYSTEMS
INGK501

Topics:
Problems of traditional data manipulation, characteristics of database approach, the three-schema architecture (internal level, conceptual level, external level), data independence, types of DBMS users, database administrator, DBMS languages, (DDL, DML, host language, data sublanguage), CODASYL (DBTG) reports, basic concepts of the network model.

Entity-Relationship model concepts: entities, attributes, relationships, types, instances, structural constraints, weak entity types, partial key, notation for Entity-Relationship (ER) diagrams

The relational data model: relation schema, relation, relational model constraints (superkey, key, foreign keys), practical questions, update operations, the relational algebra, relational calculus, functional dependencies, normal forms, normalization process, algorithms

SQL - a relational database language, embedded systems, object oriented concepts, elements of ODL.

Study of a specific DBMS

Compulsory/Recommended Readings:
- R. Elmasri – S. B. Navathe: Fundamentals of Database Systems, Addison Wesley, 2004.

- J.F.Ullman – J. Widom: A First Course in Database Systems, Prentice Hall, 1997

TECHNOLOGY OF SYSTEM DEVELOPMENT
INGK521

Topics:
Process of system development, life cycle models.Creating plan documentation. Feasibility, requirements analysis. Input/output design (HIPO). Designing logical and physical data structure. Designing procedures, dialogues and reports. Transaction planning, real time systems.

Project development, project management. Cost and risk analysis, the COCOMO modell. Planning system test, making ProtoType. Graphycal tools and diagrams. Structured methods: SDM, SSADM.

Computer aided system engineering tools (CASE).

Compulsory/Recommended Readings:
- E. Yourdon, Modern Structured Analysis, Prentice Hall, 1989.
- W.S. Davis, D.C. Yen, The information system consultant's handbook, Systems analysis and design, CRC Press, 1999.

INTRODUCTION TO COMPUTER GRAPHICS
INGK601

Topics:
Graphics hardware, graphical standards, SRGP, simple raster graphic algorithms, geometrical transformations, parallel, central and axonometric projections, approximations and interpolations of curves, representing surfaces, solid modelling, hidden line and hidden surface techniques.

Compulsory/Recommended Readings:
- FOLEY, J.,D., van DAM, A., FEINER, S.,K., HUGHES, J.,F. : Computer Graphics, Principles and Practice, Second edition in C, Addison-Wesley, Reading, Mass., 1996.
- ROGERS,D.F., ADAMS,J.A.: Mathematical elements for Computer Graphics, Mc Graw-Hill, New York, 1976., 2.nd.ed. 1990.
- WATT, Alan: 3D Computer Graphics, Addison-Wesley, Wokingham, England, 1993.

OPERATING SYSTEMS 2
INGK212

Topics:
Practical implementations of operating systems. Comparisons of types and platforms. Distributed systems. Comprehensive study of some sophisticated OS components.

Compulsory/Recommended Readings:
- Silberschatz, Abraham, Operating system concepts, Addison-Wesley, c1994, xvi, 780 p. : ill. ; 25 cm, ISBN 0 201 59292 4
- Nutt, Gary J., Operating systems : a modern perspective, Addison-Wesley, 1997. - XXII, 630 S. , ISBN 0-8053-1295-1
- William Stallings: Operating systems (Internals and design principles), Prentice Hall (4. ed.) 2001.

THEORY OF COMPUTING
Topics:
Turing machines and their time and space complexity. Simulation, theorem on simulation. Recursive and recursively enumerable languages and the relation between these language classes. Notion and existence of universal Turing-machines. The thesis of Church. Algorithmically unsolvable problem. Halting problem. RAM machines. Kolmogorov complexity and its application. Complexity classes. Non-deterministic Turing machines. The space-time theorem. Relation between the complexity classes of P and NP. The witness theorem. Examples for languages belonging to the NP class. NP complete problems. The SAT language and other NP complete languages. Basic notions of cryptography.

Compulsory/Recommended Readings:
- C. H. Papadimitriou: Computational complexity, Addison Wesley, 1994.

- T. H. Cormen, C. E. Leiserson, R.L. Rivest: Introduction to algorithms, MIT Press, Cambridge, Massachusetts, 1990.

PROGRAMMING ENVIRONMENTS
INGK311

Topics:
Compilers and interpreters. Implementations of programming languages. Integrated development environments (IDE). Preparing the source text of a program, syntax oriented text editors. The control of the compilation (compiler directives). Using of libraries. Program stimulation, debugging. Special issues of subroutine-, object-, functional-, and logical development environments. WEB-based developing, CASE tools.

Compulsory/Recommended Readings:
- W. R. Stevens: Advanced programming in the UNIX environment. Addison Wesley, 1993.
- C. Petzold: Programming Windows. Microsoft Press, 1998.

NUMERICAL METHODS
INGK141

Topics:
Floating point arithmetic. Norms, condition numbers, error estimations. Solutions of linear equations: Gaussian-elimination, LU decomposition, Cholesky decomposition. Least squares approximation. Eigenvalue problems: localization of eigenvalues, power method, inverse interpolation. Interpolation: Lagrangian interpolation, Newton recursion, Hermite interpolation. Nonlinear equations: fixpont iteration, bisection-, chord-, secant- and Newton method. Systems of nonlinear equations: Newton and Gauss-Newton method. Numerical integration: numerical quadratures, Newton-Cotes formulae, multiple integrals. Applications of the MATLAB numerical package.

Compulsory/Recommended Readings:
- Atkinson, K.E.: Elementary Numerical Analysis. John Wiley, New York, 1993.
- Lange, K.: Numerical analysis for statisticians. Springer, New York, 1999.
- Press, W.H. – Flannery, B.P. – Tenkolsky, S.A. – Vetterling, W.T.: Numerical recipes in C. Cambridge University Press, Cambridge, 1988.

OPERATIONS RESEARCH
INGV151

Topics:
Introduction to Operations Research – history, problems, real-life examples, graphical illustration of an optimization problem. Linear programming problems. Graphical illustration. Special cases. Real-life applications. The simplex method. Big-M method, 2-phase simplex method. Sensitivity analysis. Duality. Using Solver add-in for MS-Excel to solve an LP problem.

Special problems of LP: transportation problem, transshipment problem, assignment problem. Special methods.

Linear-fractional programming (LFP) – problem, theory, methods. Using WinGULF package for linear-fractional programming problems. Charnes-Cooper transformation. LINGO modeling language. Using LINGO package for solving LP and LFP problems. Integer linear programming. Branch and bound method. Gomory cutting-plane method. Using 0/1 service variables in modeling.

Network models. Blending problem. Modeling for special cases.

Compulsory/Recommended Readings:
- Bajalinov E.: Linear-fractional programming: Theory, Methods, Applications and Software. Kluwer Academic Publishers, 2003.
- Hiller F.S., Lieberman G.J.: Introduction to Operations Research, McGraw. 1990
- Nemhauser G.L., Wolsey L.A: Integer and Combinatorial Optimization. Wiley, 1999.
- Pardalos P.M. (ed.): Handbook of Applied Optimization. Oxford University Press, 2002
- Sposito V.A.: Linear and Nonlinear Programming. The IOWA State University Press, 1975.
- Stancu-Minosian I.M.: Fractional programming: Theory, Methods and Applications. Kluwer Academic Publishers, 1997.
- Taha H.A. Integer Programming: Theory, Applications, and Computations. Academic Press, 1975
- Vanderbei R.J: Linear programming: Foundations and Extensions. Kluwer Academic Publishers, 1996.
- Williams H.P.: Model Building in Mathematical Programming. Wiley, 1985.
- Winston W.L.: Introduction to mathematical programming. PWS-Kent, 1991.

INTRODUCTION TO ARTIFICIAL INTELLIGENCE
INGK141

Topics:
Artificial intelligence methods and techniques. Problem representations, state-space representation, examples. State-space graph, graph-search procedures: depth-first, breadth-first. Backtracking, optimal search strategies, heuristics. A and A* algorithms, completeness, monotone restriction. Problem-reduction representation and AND/OR graphs. Search procedures for AND/OR graphs, algorithm AO. Two-person, perfect-information games, game trees, winning strategy. Mini-max procedure, alpha-beta pruning procedure.

Compulsory/Recommended Readings:

- N. Nilsson, *Artificial Intelligence, A New Synthesis*, The Morgan Kaufmann Series in Artificial Intelligence, 1998.
- S. J. Russel, P. Norvig, *Artificial Intelligence, A Modern Approach*, Prentice-Hall, 1995.

DATABASE SYSTEM IMPLEMENTATION 1
INGV502

Topics:
Concept and properties of transaction. Failure modes. Handling system failures. Logging techniques: undo, redo, undo/redo logging. Archiving. Handling system failures in Oracle database management system. Concurrency control. Schedules and their properties. Conflict-serializability, precedence graphs. Locking systems. Two-phase locking. Various lock modes, compatibility matrices. Lock table. Operation of the locking scheduler. Warning protocol. Tree protocol. Operation of the timestamp-based scheduler. Multiversion timestamping. Operation of the validation-based scheduler. Concurrency control in Oracle. The dirty-data problem. View-serializability. Resolving deadlocks. Distributed databases, distributed commit, distributed locking. Long-duration transactions.

Compulsory/Recommended Readings:
- Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom: *Database System Implementation* Prentice-Hall, 2000

PROGRAMMING TECHNOLOGIES
INGK321

Topics:
Software crisis: questions and answers. Modular, structured and object oriented programming methodology. Formal methods. Reuse-oriented programming. The role of abstraction. Patterns. The "good" programming style. Testing. Verification and validation. Metrics. Quality management.

Compulsory/Recommended Readings:
- Ian Sommerville: Software Engineering. Addison Wesley, 2007.
- D. Galin: Software Quality Assurance: From Theory to Implementation. Addison Wesley, 2004.

TECHNOLOGY OF SYSTEM DEVELOPMENT
Topics:
The life cycle of a system development: requirements engineering, design, developments of sub-systems, system integration, installation, system evolution, system decommissioning. Software process models: waterfall, evolutionary, formal, component-based, iterative (incremental and spiral) development. Creating, documentation and validation of requirements. System models: context, behavioral, data and object models.
Design: architectural design, object-oriented design, design of user interfaces, design with reuse. Design patterns. Implementation. Prototypes. Components. Testing. Validation and verification. Metrics. Software evolution. Project management. Quality assurance. Re-engineering. Standards: UML, RUP, MDA, OPEN.

Compulsory/Recommended Readings:
- P. Stevens – R. Pooley: Using UML. Software Engineering with Objects and Components. Addison Wesley, 2000.

COMPILERS
INGV221

Topics:
Theory of compilers. Intermediate forms. Tables. Lexical, syntactic and semantic analysis. Code-generating. Top-down and bottom-up parsing. Parsing algorithms. Formal methods for semantics. Planning and analysis of compilers.

Compulsory/Recommended Readings:
- A. V. Aho – R. Sethi – J. D. Ullman: 21st Century Compilers, Addison Wesley, 2004.
- A. V. Aho – R. Sethi – J. D. Ullman: Compilers, Addison Wesley, 1986.
- T. Pittman – J. Peters: The Art of Compiler Design: Theory and Practice. Prentice Hall, 1991.
- J. Holmes: Object-Oriented Compiler Construction, Prentice Hall, 1994.

COMPUTER NETWORKS AND PROTOCOLS
INGK721

Topics:
Network topologies and architectures. Transmission media, analog and digital transmission signaling and coding. Switching methods. The ISO OSI reference model, describing the layers. Channel access methods and implementations: ALOHA protocols, CSMA, collision-free, limited-contention free.

The IEEE 802.3 standard and the ETHERNET. Token bus, token ring. Flow control of datalink layer (frames and sliding window protocols). The routing algorithms of the network layer (shortest path, centralized - distributed, hierarchical). Network layer protocols. Network security, encryption. Application layer, electronic mail, catalogue systems.

Compulsory/Recommended Readings:
- Andrew S. Tanenbaum: Computer Networks, 4th Edition, Prentice-Hall, 2003.
- William Stallings: Data and Computer Communications, 7th Edition. Prentice-Hall, 2003.
- Regis J. (Bud) Bates, Donald W. Gregory: Voice and Data Communications Handbook, 4th Edition, McGraw-Hill, 2001.
- RFC Documents: http://www.rfc-editor.org/

DEVELOPING AND ANALYSING ALGORITHMS
INGK451

Topics:
Program semantics: operational, denotational and axiomatic semantics. Program correctness. Program verifications. Stepwise INRuction method for Floyd Naur style proofs, Hoare logic, Dijkstra weakest precondition. Other programming paradigms: special properties of parallel programs. Owicki-Gries's and Stirling's method for parallel program verifications. Nondeterminism, Dijkstra's guarded commands. Kröger's program model, temporal logic characterization of program properties. Recursive program schemas.

Compulsory/Recommended Readings:
- F. Kröger, Temporal Logic of Programs, Springer-Verlag, 1987.
- E. W. Dijkstra, Guarded Commands, nondeterminacy and formal derivation of Programs, Comm. of the ACM 18, 1975.
- Owicki, Gries, Verifying properties of parallel programs: An axiomatic approach, Comm. of the ACM 19, 1976.

INTERNET TOOLS AND SERVICES
INGK231

Topics:
The role, use and implementation of internet tools from programming aspect. Client-server and multi-layer architectures in relation to internet. Text, image, sound, video usage. Standards and protocols. Security problems. Server-client programming. Databases. Web-technologies. TCP/IP, HTTP, HTML, XML, DOM, CORBA. CGI scripts. JavaScript, PHP, Perl. Web-services: SOAP, UDDI, WSDL.

Compulsory/Recommended Readings:
- W. G. Lehnert: Web 101: Making the Net Work for You, Addison Wesley, 2003.
- R. W. Sebesta: Programming the World Wide Web. Addison Wesley, 2003, ISBN 0-321-14945-9.
- E. Newcomer: Understanding Web Services: XML, WSDL, SOAP, and UDDI. Addison Wesley, 2002, ISBN 0-201-75081-3.

PROGRAMMING LANGUAGES OF ARTIFICIAL INTELLIGENCE
INGV442

Topics:
Lists, operators and arithmetic in Prolog. Structured information retrieving from databases. Simulation of a non-deterministic automata. Managing the backtrack. Sorting programs in Prolog. Prolog representation and procedures of graphs and trees. Simulation of elementary searching methods: depth-first, breadth-first, heuristic. Planning and Prolog in Expert Systems.

Compulsory/Recommended Readings:
- Bratko: Prolog Programming for Artificial Intelligence, Addison-Wesley, 1990.
- S. K. Das: Deductive databases and logic programming. Addison Wesley, 1992.
- Sterling, Shapiro: The Art of Prolog, The MIT Press, 1994

KNOWLEDGE BASED SYSTEMS
INGV443

Topics:
Architecture and developing of knowledge based systems. Expert systems. Knowledge base and reasoning. Knowledge representation: semantic net, frame based and rule based systems, description logic. Reasoning methods, case based reasoning. Non-deterministic and fuzzy concepts. Case studies.

Compulsory/Recommended Readings:
- J. D. Ullman: Principles of Database and Knowledge-Base Systems, Computer Science Press, 1989.

SOME ASPECTS OF ARTIFICIAL INTELLIGENCE
INGV444

Topics:
Some advanced topics in Artificial Intelligence (searching algorithms, restriction satisfaction, machine learning, multi agent systems, speech recognition, etc.). Notions, methods, tools amd applications.

Compulsory/Recommended Readings:
- J. D. Ullman: Principles of Database and Knowledge-Base Systems, Computer Science Press, 1989.
- Jérôme Euzenat, John Domingue: Artificial Intelligence: Methodology, Systems, and Applications, 12th International Conference, AIMSA 2006, Varna, Bulgaria, September 12-15, 2006, Proceedings. AIMSA 2006, Springer, ISBN 3-540-40930-0 [DBLP:conf/aimsa/2006]

DATABASE SYSTEM IMPLEMENTATION 2
INGV503

Topics:
The query compiler. Syntax analysis and parse trees. The preprocessor. Algebraic laws for improving query plans. Transforming parse trees to logical query plans. Improving logical query plans. Estimating the cost of operations. Cost-based plan selection. Heuristics for reducing the cost of logical query plans. Choosing the order of joins. Join trees. Dynamic programming to select a join order and grouping. Selection of physical query plan. Choosing the method for selection and join. Pipelining and materialization. Ordering of physical operations. The query compiler in Oracle database management system.

Compulsory/Recommended Readings:
- Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom: *Database System Implementation,* Prentice-Hall, 2000.

ADVANCED DBMS 1
INGV531

Topics:

PL/SQL, the procedural languages of Oracle. The basic elements of PL/SQL. Data types, conversions. Expressions. Statements, control flow. SQL statements in PL/SQL. The structure of a PL/SQL program. Blocks and subprograms. Scope and life time. Running of a PL/SQL program. Predefined functions. Exception handling. Stored subprograms. Cursors, cursor variables. Packages. Transaction management. Triggers. Testing. The native dynamic SQL. Predefined packages. Optimalization. Implementation of applications in PL/SQL.

Compulsory/Recommended Readings:

Urman, Scott - Hardman, Ron - McLaughlin, Michael: ORACLE DATABASE 10*g* PL/SQL Programming. McGraw-Hill/Osborne, 2004.

ADVANCED DBMS 2
INGV532

Topics:

The object-relational elements of Oracle: collections, object types. The object-relational model of Oracle. Object tables and object views. References. Privileges. Triggers and object-relational features. Management of relationships. Predefined object-relational features. Object-relational modelling. Object-relational applications in PL/SQL. Java and Oracle. Java stored subprograms, JDBC, SQLJ, JSP, EJB. Java and PL/SQL. Java applications in Oracle.

Compulsory/Recommended Readings:
- Urman, Scott - Hardman, Ron - McLaughlin, Michael: ORACLE DATABASE 10*g* PL/SQL Programming. McGraw-Hill/Osborne, 2004.

SERVER ADMINISTRATION
INGV702

Topics:

The target of this class is to give deep knowledge of administration of current server based information systems (including operating systems and database systems).

At the end of the semester the students will be able to perform advanced configuration and tuning tasks on the real systems based on the acurate knowlegde of theory and practice.

Compulsory/Recommended Readings:
- Gian-Paolo D. Musumeci, Mike Loukides: System Performance Tuning (2nd Edition), O'Reilly & Associates; 2002.
- Microsoft Official Curriculum - 2151, 2152, 2153; 2071, 2072, 2073.
- Antony Sequeira: The SQL Server 2000 Book, Paraglyph Pub; 2003.
- Lance Mortensen-Rick Sawtell-Joseph L. Jorden: MCSE Microsoft Server 2000 Administration: Study Guide, Sybex; 2003.

HIGH SPEED LOCAL- AND METROPOLITAN AREA NETWORKS
INGV722

Topics
Networking generations and the different technologies of the generations. Examples and study of current high speed networking technologies. Multipurpose networks (Data, voice, video, fax, etc.) and the integration solution methods.

Compulsory/Recommended Readings:
- Andrew S. Tanenbaum: Computer networks (4th ed.), P rentice Hall; 2003.
- Stephen A. Thomas: •   Stephen A. Thomas: IP Switching and Routing Essentials, Wiley, 2001.
- Regis J. (Bud) Bates, Donald W. Gregory: Voice and Data Communications Handbook, 4th Edition, McGraw-Hill, 2001.

ACTUAL PROBLEMS OF VOICE AND DATA COMMUNICATION
INGV723

Topics:
The lecture investigates the actual problems of voice and data networking and the most important solutions. E.g.: Voice over IP (VoIP), Quality of Sevice (QoS), multiprotocol switching and advanced routing technologies, wireless communication.

Compulsory/Recommended Readings:
- William Stallings: Data and Computer Communications (7th edition), Prentice-Hall; 2003.
- RFC Documents – http://www.rfc-editor.org/

PERFORMANCE EVALUATION OF COMPUTER NETWORKS
INGV724

Topics:
Renewal Theory. Poisson Process. Markov Chains, Birth-Death Processes. Basic Queuing Models. Markov-type queuing networks, finite and infinite - source queuing systems and their applications in performance analysis. Modeling tools.

Compulsory/Recommended Readings:
- **Haverkort B.**: Performance of computer communication systems: a model-based approach, J. Wiley, 1998.
- **Daigle J.N.:** Queueing Theory for Telecommunications, Addison-Wesley, 1992
- **Gross D., Harris C.*:* Fundamentals of Queueing Theory, John Wiley, New York, 1985
- **Hayes J.F. , Babu T.V.J.:** Modeling and Analysis of Telecommunication Networks, Wiley-Interscience, 2004

COMPUTER GRAPHICS
INGV602

Topics:
Graphical tools in informatics.
Main fields of the computer graphics (economical, engineering, entertainment).
Problems of 2D (curves, lines, functions, intersections).
Problems of 3D (projections of space, polyhedron models, wire-frame, surface and volumetric models).
Curve surfaces. Visibility issues.

Compulsory/Recommended Readings:
- FOLEY, J.,D., van DAM, A., FEINER, S.,K., HUGHES, J.,F. : Computer Graphics, Principles and Practice, Second edition in C, Addison-Wesley, Reading, Mass., 1996.
- ROGERS,D.F., ADAMS,J.A.: Mathematical elements for Computer Graphics, Mc Graw-Hill, New York, 1976, 2.nd.ed. 1990.
- WATT, Alan: 3D Computer Graphics, Addison-Wesley, Wokingham, England, 1993.
- Hoschek J., Lasser D. : Grundlagen der Geometrischen Datenverarbeitung (in English)

GRAPHICAL SYSTEMS
INGV603

Topics:
Mathematical, geometrical and information background of the most actual computer aided design graphical systems. (AutoCAD, CADKEY, GIS, OpenGL) Possible directions of software design.

Compulsory/Recommended Readings:
- H. Stachel - G. Glaeser: Open Geometry: OpenGL + Advanced Geometry. . Springer-Verlag, New York 1999, 377 pp. (ISBN 0-387-98599-9), http://www.uni-ak.ac.at/opengeom/
- Jackie Neider, Tom Davis, Mason Woo: OpenGL Programming Guide, Addison-Wesley Publishing Company

GIS
INGV611

Topics:
Overview of representing the real-world from the point of view of geographical information systems.
Grouping of data collection methods, and discussing of its main characteristics. The process of data collection and the quality of data.
Properties of the vector, raster and hybrid data models. Operation of geographical information systems.
Outline of some essential algorithms
Studying, using and developing of current GIS software(s).

Compulsory/Recommended Readings:
- P.A. Longley, M. F. Goodchild, D. J. Maguire, D. W. RhINR, Geographic Information Systems and Science, John Wiley & Sons, England, 2005.
- David Martin, Geographic Information Systems, Routledge, London, 1996.
- Christopher Jones, Geographical Information Systems and Computer Cartography, Addison Wesley Longman, England, 1997
- User Guides, Manuals of GIS Softwares

MULTIMEDIA
INGV621

Topics:
The computer based multimedia, multimedia hardware, networks, applications. Multimedia data and modeling, information retrieval, memory management. Multimedia environments and presentations. Frame systems, authoring and engineering.

Compulsory/Recommended Readings:
- R.S. Tannenbaum: Theoretical foundations of multimedia, Comp. Sci. Press, 1998.
- S.J. Gibbs, D.C. Tsichritzis: Multimedia programming (Objects, environments and frameworks), Addison-Wesley, 1995.
- W.I.Gorsky & al. (ed): The Handbook of multimedia information management, Prentice Hall, 1997.

INFORMATION THEORY
INGV122

Topics:
General model of communication. Problem of coding: uniquely decodable and irreducible codes, Kraft-Fano inequility, McMillan's theorem, optimal codes, method of coding. Block coding. Notion of information measure, Shannon entropy. Discrete memoryless chanel, chanel capacity. The main theorems of information theory. Data compression. Continuous chanels. Basic notions of error correcting encoding.

Compulsory/Recommended Readings:
- MacKay, D.: Information Theory, Inference, and Learning Algorithms, Cambridge University Press, Cambridge, 2003.
- Hankersson, D. R., Harris, G. A., Johnson, P. D.: Introduction to Information Theory and Data Compression, CRC Press, 1997.
- Gray, R. M.: Entropy and Information Theory, Springer, New York, 1990.
- Ash, R. B.: Information Theory, New York, Dover Publications, 1965.
- Csiszár, I., Körner, J.: Information Theory: Coding Theorems for Discrete Memoryless Systems, Budapest, New York, Akadémiai Kiadó, 1981.

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NEURAL NETWORKS
INGV123

Topics:
Basic concepts of neural networks: neuron, activation function. Network architectures, learning algorithms. Linearly separable patterns and the perceptron. Adaptive filtering. Multilayer perceptron, back-propagation algorithm. Radial-basis function networks. Support vector machine and its applications. Self organising map, Kohonen network. Methods presented at lectures are applied for data at practices.

Compulsory/Recommended Readings:
- Haykin, S.: Neural Networks. A Comprehensive Foundation. Prentice Hall. New Jersey, 1999.
- Titterington, D.M. – Kay, J.W.: Statistics and Neural Networks. Oxford University Press, Oxford, 1999.
- Matlab Neural Network Toolbox. The Mathworks, Inc., Natick, 1998.

The map of the campus

The new building of Faculty of Informatics at Kassai Campus
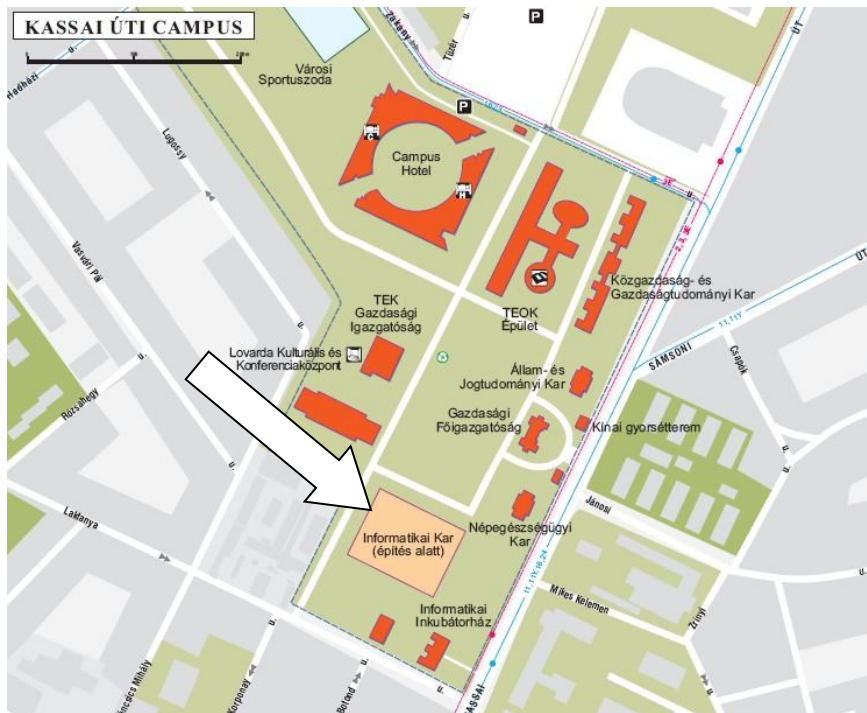
Photos

The largest lecture hall for 196 persons

Seminar room

Inside the building

"Green wave" park in front of our building

Professional Student's Days at Faculty