

INFORMATICS

Study programme Informatics

(Chosen courses, Magister study)

Code Title ECTS Credit Hours/week Assessment Recommended Year/Semester

Compulsory courses

ÚINF/VYZ1/04	Computational Complexity	4	2/-	Examination	1/1
ÚINF/SMI1/08	Statistical Methods for Informatics	5	3/1	Examination	1/2

Compulsory elective courses

ÚINF/KPI1/01	Encoding and Transfer of Information	4	2/1	Examination	1/1, 2/3
ÚINF/KRP1/06	Cryptographic Protocols	4	2/1	Examination	1/1
ÚINF/NEU1/03	Neural Networks	5	2/1	Examination	1/1
ÚINF/SPS1/00	Network Programming Seminar	3	-/3	Assessment	1/1
ÚINF/KKV1/06	Classical and Quantum Computations	6	3/1	Examination	1/1, 2/3
ÚINF/LAD1/06	Logical Aspects of Databases	4	2/-	Examination	1/2
ÚINF/AIS1/01	Architecture of Information Systems	4	2/1	Examination	1/2
ÚINF/VYU1/03	Computational Learning	5	2/1	Examination	1/2
ÚINF/PDS1/03	Parallel and Distributed Systems	4	2/1	Examination	1/1, 2/4
ÚINF/ARP1/05	Architecture of Computers	4	2/1	Examination	1/1, 2/3
ÚINF/VKN/12	Computational and cognitive neuroscience	4	2/1	Examination	2/3
ÚINF/UII1/06	Introduction to Artificial Intelligence	3	2/-	Examination	2/3

Course units

Compulsory courses

<i>Title</i>	Computational Complexity
<i>Code</i>	ÚINF/VYZ1/04 <i>Teacher</i> Geffert Viliam
<i>ECTS credits</i>	4 <i>Hrs/week</i> 2/-
<i>Assessment</i>	Examination <i>Semester</i> 1
<i>T/L method</i>	Lecture
<i>Objective</i>	To give students background in the computational complexity and theory of NP-completeness.
<i>Content</i>	Deterministic and nondeterministic algorithms with polynomial time; NP-completeness. Deterministic simulation of a nondeterministic Turing machine. Satisfiability of Boolean formulae. Other NP-complete problems: satisfiability of a formula in a conjunctive normal form, 3-satisfiability, 3-colorability of a graph, 3-colorability of a planar graph, knapsack problem, balancing, etc. Space bounded computations, classes LOG-space and P-space. Deterministic simulation: Savitch's theorem. Closure under complement. Classification of computational complexity of problems.

<i>Recommended reading</i>	AHO, A. V. and ULLMAN, J.D.: The design and analysis of computer algorithms. Addison-Wesley, 1974 van EMDE BOAS, P.: Machine models and simulations. In J.van Leeuwen (ed.): Handbook of theoretical computer science. North-Holland, 1990 YAP, Ch.K.: Introduction to the theory of complexity classes. To be published by Oxford Univ. Press. (Electronic version available via anonymous ftp://cs.nyu.edu/pub/local/yap/complexity-bk).
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<i>Title</i>	Statistical Methods for Informatics		
<i>Code</i>	ÚINF/SMI1/08	<i>Teacher</i>	Török Csaba
<i>ECTS credits</i>	5	<i>Hrs/week</i>	3/1
<i>Assessment</i>	Examination	<i>Semester</i>	2
<i>T/L method</i>	Lecture		
<i>Objective</i>	To understand probability and statistical terms and principles. Make students familiar with the base stochastic and statistical methods and techniques for modeling and data processing.		
<i>Content</i>	Randomness, probability. Laws of probability distributions, characteristics of location, variability and dependency. Samples, estimates and tests of hypotheses. Modeling of dependencies, noise. Bayes theory of decision. Pseudorandom values and Monte Carlo method.		
<i>Recommended reading</i>	ALPAYDIN E.: Introduction To Machine Learning, MIT Press, 2004 - http://www2.chass.ncsu.edu/garson/pa765/statnote.htm - http://www.statsoft.com/textbook/stathome.html - http://www.r-project.org/		

Compulsory elective courses

<i>Title</i>	Encoding and Transfer of Information		
<i>Code</i>	ÚINF/KPI1/01	<i>Teacher</i>	Krajčí Stanislav, Jirásek Jozef
<i>ECTS credits</i>	4	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	1, 3
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To provide students knowledge of basic principles of information theory, coding and data compression.		
<i>Content</i>	Introduction to information theory: entropy, Markov models. Huffman coding, adaptive Huffman coding, applications. Arithmetic coding, dictionary techniques, applications. Lossless image compression. Scalar and vector quantisations. Differential encoding, delta modulation, subband coding, wavelets. Transform coding, DFT, DCT, application to JPEG. Analysis/synthesis schemes; fractal compression. Video compression.		
<i>Recommended reading</i>	HANKERSON, D., HARRIS, G., JOHNSON, P.: Introduction to Information Theory and Data Compression, CRC Pr.,1998 SAYOOD, K.: Introduction to Data Compression, Morgan Kaufmann, 1996		

<i>Title</i>	Cryptographic Protocols		
<i>Code</i>	ÚINF/KRPI/06	<i>Teacher</i>	Jirásek Jozef

<i>ECTS credits</i>	4	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	1
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To teach students about the design and verification of cryptographic protocols		
<i>Content</i>	Authentication and key establishment using shared and public key cryptography, key agreement protocols, conference key agreement, zero-knowledge protocols.		
<i>Recommended reading</i>	BOYD, C., MATHURIA, A.: Protocols for Authentication and Key Establishment, Springer, 2003 STINSON, D. R.: Cryptography: Theory and Practice, Third Edition, Chapman & Hall/CRC, 2006 SCHNEIER, B.: Applied Cryptography, Second Edition, John Wiley & Sons Inc., 1996 RYAN, P., SCHNEIDER, S.: Modelling and Analysis of Security Protocols, Addison-Wesley, 2001		

<i>Title</i>	Neural Networks		
<i>Code</i>	ÚINF/NEU1/03	<i>Teacher</i>	Andrejková Gabriela
<i>ECTS credits</i>	5	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	1
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To establish student understanding and knowledge for using basic paradigms of neural networks.		
<i>Content</i>	Feed-forward and recurrent neural networks; back propagation algorithm to adaptation of neural networks; capability of neural networks to be universal approximators. Hopfield neural networks and solving optimisation problems. Kohonen neural networks. Neural networks in connections to computational models. Theoretical problems of neural networks.		
<i>Recommended reading</i>	HAYKIN, S. O.: Neural Networks and Learning Machines, Prentice Hall, 1999, 2008 HERTZ, J., KROGH, A., PALMER, R.G.: Introduction to the theory of neural computation, Addison Wesley, 1991		

<i>Title</i>	Network Programming Seminar		
<i>Code</i>	ÚINF/SPS1/00	<i>Teacher</i>	Jirásek Jozef, Krivoš-Belluš Rastislav
<i>ECTS credits</i>	3	<i>Hrs/week</i>	-/3
<i>Assessment</i>	Assessment	<i>Semester</i>	1
<i>T/L method</i>	Practical		
<i>Objective</i>	To teach students current technologies of programming in a network distributed environment.		
<i>Content</i>	Basics of programming client-server applications, iterative and concurrent servers, Remote Procedure Calls. Server-side programming, CGI, PHP, basics of Perl and Python. Script languages, ASP, JSP, Component Object Model, Corba, database connection's interfaces. Document Object Model, XML, XSL, dynamic extensions of HTML. Advanced level of programming is expected.		
<i>Recommended reading</i>	Internet sources and specifications.		

<i>Title</i>	Classical and Quantum Computations		
<i>Code</i>	ÚINF/KKV1/06	<i>Teacher</i>	Semanišin Gabriel
<i>ECTS credits</i>	6	<i>Hrs/week</i>	3/1
<i>Assessment</i>	Examination	<i>Semester</i>	1, 3
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To provide information on quantum computer and quantum computations. To compare classical and quantum models and methods.		
<i>Content</i>	The basics of classical theory of computation: Turing machines, Boolean circuits, parallel algorithms, probabilistic computation, NP-complete problems, and the idea of complexity of an algorithm. Introduction of general quantum formalism (pure states, density matrices, and superoperators), universal gate sets and approximation theorems. Grover's algorithm, Shor's factoring algorithm, and the Abelian hidden subgroup problem. Parallel quantum computation, a quantum analogue of NP-completeness, and quantum error-correcting codes.		
<i>Recommended reading</i>	BERMAN, G.P., DOOLEN, G.D., MAINIERI, R., TSIFRINOVIC, V.I.: Introduction to Quantum Computers. World Scientific, 2003. GRUSKA, J.: Quantum Computing. McGraw-Hill, 1999. JOHNSON, G.: A Shortcut Through Time: The Path to the Quantum Computer, Knopf 2003. KITAEV, A.Y., SHEN, A.H., VYALYI, M.N.: Classical and Quantum Computation. American Mathematical Society, 2002. NIELSEN, M.A., CHUANG, I.L.: Quantum Computation and Quantum Information. Cambridge University Press, 2000. HIRVENSALO, M.: Quantum Computing, Springer 2004		

<i>Title</i>	Logical Aspects of Databases		
<i>Code</i>	ÚINF/LAD1/06	<i>Teacher</i>	Krajči Stanislav
<i>ECTS credits</i>	4	<i>Hrs/week</i>	2/-
<i>Assessment</i>	Examination	<i>Semester</i>	2
<i>T/L method</i>	Lecture		
<i>Objective</i>	To have students understand and be able to formalise relationships between databases, first order logic and logic programming.		
<i>Content</i>	Relationships between databases, logic and logic programming.		
<i>Recommended reading</i>	ABITEBOUL, S., HULL, R., VIANU, V.: Foundations of Databases. Addison-Wesley 1995		

<i>Title</i>	Architecture of Information Systems		
<i>Code</i>	ÚINF/AIS1/01	<i>Teacher</i>	Semanišin Gabriel
<i>ECTS credits</i>	4	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	2
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To provide an overview of the modern methodologies of information system development. To introduce the fundamental principles of conceptual modelling of information systems.		
<i>Content</i>	System, information system, information pyramid. Conceptualisation of information systems. ISO model of the architecture of an information		

	system. Introduction to MDA, software development life cycle based on MDA. Model, metamodel, modelling language. Model transformation and marking models. Entity types. Relationship types. Cardinality constraints. Integrity constraints. Taxonomies. Domain events. Use cases. State transition diagrams.
<i>Recommended reading</i>	BEYEDA, S., BOOK, M., GRUHN, V.: Model-Driven Software Development, Springer 2005. GAŠEVIČ, D., DJURIČ, D., DEVEDZIČ, V.: Model Driven Architecture and Ontology Development, Springer 2006. KLEPPE, A., BAST, W., WARMER, J. B.: The Model Driven Architecture: Practice and Promise, Addison-Wesley 2003 (http://www.klasse.nl/) MELLOR, S. J., SCOTT, K., UHL, A., WEISE, D.: MDA Distilled, Addison-Wesley 2004 OLIVÉ, A.: Conceptual Modelling of Information Systems, Springer 2007

<i>Title</i>	Computational Learning		
<i>Code</i>	ÚINF/VYU1/03	<i>Teacher</i>	Andrejková Gabriela
<i>ECTS credits</i>	5	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	2
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To provide students with basic knowledge about computational learning algorithms.		
<i>Content</i>	Concepts, hypotheses, learning algorithms. Boolean formulae and representation, learning algorithms for disjunctions. Probabilistic learning, consistent algorithms and learnability, efficient learning, probably approximately correct (PAC) learning, Occam algorithms, Vapnik-Cervonenkis (VC) dimension and learning algorithms.		
<i>Alternate courses</i>	ÚINF/VYU1/00		
<i>Recommended reading</i>	ANTHONY, M., BIGGS, N.: Computational Learning Theory, Cambridge University Press, 1991 KEARNS, M. J., VAZIRANI, U. V.: An Introduction to Computational Learning Theory, MIT Press London, 1994		

<i>Title</i>	Parallel and Distributed Systems		
<i>Code</i>	ÚINF/PDS1/03	<i>Teacher</i>	Jirásek Jozef
<i>ECTS credits</i>	4	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	2, 4
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To introduce students to the fundamentals of parallel and distributed programming		
<i>Content</i>	Current parallel and distributed architectures; basic issues in parallel and distributed applications development; data structures and programming methodologies		
<i>Alternate courses</i>	ÚINF/PDS1/00		
<i>Recommended reading</i>	BERMAN, K. A. and PAUL, J. L.: Algorithms: Sequential, Parallel, and Distributed, Thomson, 2005 ANDREWS, G. R.: Foundations of Multithreaded, Parallel, and Distributed		

Programming, Addison-Wesley, 2000
 JÁJÁ, J.: An Introduction to Parallel Algorithms, Addison-Wesley, 1992
 TEL, G.: Introduction to Distributed Algorithms, Cambridge University Press, 1994

<i>Title</i>	Architecture of Computers		
<i>Code</i>	ÚINF/ARPI/05	<i>Teacher</i>	Jirásek Jozef
<i>ECTS credits</i>	4	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	2, 4
<i>T/L method</i>	Lecture, Practical		
<i>Objective</i>	To provide students with knowledge of the basic principles of computer architecture.		
<i>Content</i>	Milestones in computer organisation; fundamental limitations. The representation of numbers and the implementation of floating point arithmetic. Combinatorial and sequential circuits, memory organisation, RAMs and ROMs. Digital logic level architecture, data path timing, machine cycle. The microarchitecture level: microinstructions and microinstruction control. The instruction set architecture level: data types, addressing modes, instruction types. Instruction execution, pipelining, cache memory. I/O controllers, ports, interrupts, direct memory access. Device drivers, operating system kernel, device-independent software.		
<i>Recommended reading</i>	TANENBAUM, A. S.: Structured Computer Organisation, 4.ed., Prentice-Hall, 1999 STALLINGS, W.: Computer Organisation and Architecture, 4.ed., Prentice-Hall, 1996 BLIEBERGER, J., SCHILDT, G. H., SCHMID, U., STOECKLER, S.: Informatik, Springer-Verlag, 1990		

<i>Title</i>	Computational and cognitive neuroscience		
<i>Code</i>	ÚINF/VKN/12	<i>Teacher</i>	Kopčo Norbert
<i>ECTS credits</i>	4	<i>Hrs/week</i>	2/1
<i>Assessment</i>	Examination	<i>Semester</i>	3
<i>T/L method</i>	Lecture		
<i>Objective</i>	Advanced topics in study of the central nervous system and cognitive processes in human, with focus on computational concepts important in the study of cognitive and neural sciences. Prerequisite: Intro to Neuroscience		
<i>Content</i>	Selected topics in cognitive science (following up on Intro to Neuroscience). Overview of the methods of theoretical study in cognitive and neural science, including connectionistic, statistical and system-theory principles in modeling of cognitive processes and neural circuits. Selected models of the human visual and auditory systems, learning, thinking, attention, development and plasticity.		
<i>Recommended reading</i>	HERTZ, J., KROGH, A. and PALMER R. G.: Introduction to the theory of neural computation. Addison-Wesley 1991 KANDEL, E. R., SCHWARTZ, J. H. and JESSELL, T.M.: Principles of Neural Science. McGraw-Hill, 2000 DAYAN, P. and ABBOTT, L. F.: Theoretical Neuroscience – Computational and Mathematical Modeling of Neural Systems. MIT Press, 2001		

<i>Title</i>	Introduction to Artificial Intelligence		
<i>Code</i>	ÚINF/UUI1/06	<i>Teacher</i>	Gallová Štefánia
<i>ECTS credits</i>	3	<i>Hrs/week</i>	2/-
<i>Assessment</i>	Examination	<i>Semester</i>	4
<i>T/L method</i>	Lecture		
<i>Objective</i>	To familiarise students with basic information about artificial intelligence techniques. To give students the opportunity to study the literature of the field more deeply as required.		
<i>Content</i>	Goal of artificial intelligence, natural intelligence, edges of agent machine intelligence. Knowledge representation in AI (semantic networks, frames), reasoning. Problem solving in status space: non-informed versus informed deep and wide search, A*, solving of problems described as the game, iterative enhancement algorithms, problem solving by decomposition. Planning and scheduling, constraint logic programming, machine learning; computer vision: image recognition (flag described objects recognition, structural scene analysis), image preprocessing, image representation and description, object recognition. Natural language processing, artificial neural networks, knowledge systems (structure, characteristics, direct and backward reasoning, working with vague information), genetic algorithms, distributed artificial intelligence and multi-agent systems.		
<i>Recommended reading</i>	RUSSELL, S. J., NORVIG, P: Artificial Intelligence: A Modern Approach (2nd Edition), Prentice Hall, 2002 NEGNEVITSKY, M.: Artificial Intelligence: A Guide to Intelligent Systems (2nd Edition), Addison Wesley, 2004 LUGER, G.: Artificial Intelligence: Structures and Strategies for Complex Problem Solving (5th Edition), Addison Wesley, 2004		