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/UUI1/06	Introduction to Artificial Intelligence	3	2/-	Examination	2/3

Course units

Compulsory courses

Title	**Computational Complexity**		
Code	ÚINF/VYZ1/04	*Teacher*	Geffert Viliam
ECTS credits	4	*Hrs/week*	2/-
Assessment	Examination	*Semester*	1
T/L method	Lecture		
Objective	To give students background in the computational complexity and theory of NP-completeness.		
Content	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.		

Recommended reading	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).

Title	**Statistical Methods for Informatics**		
Code	ÚINF/SMI1/08	*Teacher*	Török Csaba
ECTS credits	5	*Hrs/week*	3/1
Assessment	Examination	*Semester*	2
T/L method	Lecture		
Objective	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.		
Content	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.		
Recommended reading	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

Title	**Encoding and Transfer of Information**		
Code	ÚINF/KPI1/01	*Teacher*	Krajči Stanislav, Jirásek Jozef
ECTS credits	4	*Hrs/week*	2/1
Assessment	Examination	*Semester*	1, 3
T/L method	Lecture, Practical		
Objective	To provide students knowledge of basic principles of information theory, coding and data compression.		
Content	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.		
Recommended reading	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		

Title	**Cryptographic Protocols**		
Code	ÚINF/KRP1/06	*Teacher*	Jirásek Jozef

ECTS credits	4	*Hrs/week*	2/1
Assessment	Examination	*Semester*	1
T/L method	Lecture, Practical		
Objective	To teach students about the design and verification of cryptographic protocols		
Content	Authentication and key establishment using shared and public key cryptography, key agreement protocols, conference key agreement, zero-knowledge protocols.		
Recommended reading	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		

Title	**Neural Networks**		
Code	ÚINF/NEU1/03	*Teacher*	Andrejková Gabriela
ECTS credits	5	*Hrs/week*	2/1
Assessment	Examination	*Semester*	1
T/L method	Lecture, Practical		
Objective	To establish student understanding and knowledge for using basic paradigms of neural networks.		
Content	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.		
Recommended reading	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		

Title	**Network Programming Seminar**		
Code	ÚINF/SPS1/00	*Teacher*	Jirásek Jozef, Krivoš-Belluš Rastislav
ECTS credits	3	*Hrs/week*	-/3
Assessment	Assessment	*Semester*	1
T/L method	Practical		
Objective	To teach students current technologies of programming in a network distributed environment.		
Content	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.		
Recommended reading	Internet sources and specifications.		

Title	**Classical and Quantum Computations**		
Code	ÚINF/KKV1/06	*Teacher*	Semanišin Gabriel
ECTS credits	6	*Hrs/week*	3/1
Assessment	Examination	*Semester*	1, 3
T/L method	Lecture, Practical		
Objective	To provide information on quantum computer and quantum computations. To compare classical and quantum models and methods.		
Content	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.		
Recommended reading	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		

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

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

Title	**Computational Learning**		
Code	ÚINF/VYU1/03	*Teacher*	Andrejková Gabriela
ECTS credits	5	*Hrs/week*	2/1
Assessment	Examination	*Semester*	2
T/L method	Lecture, Practical		
Objective	To provide students with basic knowledge about computational learning algorithms.		
Content	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.		
Alternate courses	ÚINF/VYU1/00		
Recommended reading	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		

Title	**Parallel and Distributed Systems**		
Code	ÚINF/PDS1/03	*Teacher*	Jirásek Jozef
ECTS credits	4	*Hrs/week*	2/1
Assessment	Examination	*Semester*	2, 4
T/L method	Lecture, Practical		
Objective	To introduce students to the fundamentals of parallel and distributed programming		
Content	Current parallel and distributed architectures; basic issues in parallel and distributed applications development; data structures and programming methodologies		
Alternate courses	ÚINF/PDS1/00		
Recommended reading	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

Title	**Architecture of Computers**		
Code	ÚINF/ARP1/05	*Teacher*	Jirásek Jozef
ECTS credits	4	*Hrs/week*	2/1
Assessment	Examination	*Semester*	2, 4
T/L method	Lecture, Practical		
Objective	To provide students with knowledge of the basic principles of computer architecture.		
Content	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 microinstrucion 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.		
Recommended reading	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		

Title	**Computational and cognitive neuroscience**		
Code	ÚINF/VKN/12	*Teacher*	Kopčo Norbert
ECTS credits	4	*Hrs/week*	2/1
Assessment	Examination	*Semester*	3
T/L method	Lecture		
Objective	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 Neurosicence		
Content	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.		
Recommended reading	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		