Study plan

Name of study plan: Master Specialization Digital Business Engineering, 2023

Faculty/Institute/Others: Department: Branch of study guaranteed by the department: Welcome page Garantor of the study branch: Program of study: Informatics Type of study: Follow-up master full-time Required credits: 106 Elective courses credits: 14 Sum of credits in the plan: 120 Note on the plan:

Name of the block: Compulsory courses in the program Minimal number of credits of the block: 56 The role of the block: PP

Code of the group: NIE-DBE-PP.23

Name of the group: Compulsory Courses of Master Study Program for Students of Specialization Dig. Business Engineerng

Requirement credits in the group: In this group you have to gain 56 credits

Requirement courses in the group: In this group you have to complete 5 courses

Credits in the group: 56

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NIE-KOP	Combinatorial Optimization Petr Fišer, Jan Schmidt Petr Fišer Petr Fišer (Gar.)	Z,ZK	6	3P+1C	Z	PP
NIE-DIP	Diploma Thesis Zden k Muziká Zden k Muziká Zden k Muziká (Gar.)	Z	30	270ZP	L,Z	PP
NIE-MPI	Mathematics for Informatics Francesco Dolce Št pán Starosta Št pán Starosta (Gar.)	Z,ZK	7	3P+2C	Z	PP
NIE-PDP	Parallel and Distributed Programming Pavel Tvrdík Pavel Tvrdík Pavel Tvrdík (Gar.)	Z,ZK	6	2P+2C	L	PP
NIE-VSM	Selected statistical Methods Petr Novák Pavel Hrabák Pavel Hrabák (Gar.)	Z,ZK	7	4P+2C	L	PP

Characteristics of the courses of this group of Study Plan: Code=NIE-DBE-PP.23 Name=Compulsory Courses of Master Study Program for Students of Specialization Dig. Business Engineerng

NIE-KOP	Combinatorial Optimization	Z,ZK	6
The students will gain k	nowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not	only to select and	implement but
also to apply and evaluate	ate heuristics for practical problems.		
NIE-DIP	Diploma Thesis	Z	30
NIE-MPI	Mathematics for Informatics	Z,ZK	7
The course focuses on s	elected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from multi-var	iate analysis, smo	oth optimization,
and multi-variate integra	ation. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The	he last topic includ	des selected
numerical algorithm and	t their stability analysis. The topics are completed with the demonstration of applications in computer science. The course for	uses on clear pre	sentation and
argumentation.			
NIE-PDP	Parallel and Distributed Programming	Z,ZK	6
21st century in compute	r architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing co	res. Parallel comp	uting systems
are becoming a ubiquite	ous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platf	iorms. Students g	et acquainted
with architectures of pa	rallel and distributed computing systems, their models, theory of interconnection networks and collective communication ope	rations, and langu	lages and
environments for paralle	el programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and	on selected proble	ems, they will
learn the techniques of	design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The cou	rse includes a ser	mester project of
practical programming i	n OpenMP and MPI for solving a particular nontrivial problem.		
NIE-VSM	Selected statistical Methods	Z,ZK	7
Summary of probability	heory; Multivariate normal distribution; Entropy and its application to coding; Statistical tests: T-tests, goodness of fit tests, indep	pendence test; Ra	ndom processes
- stacionarity; Markov cl	nains and limiting properties; Queuing theory		

Code of the group: NIE-DBE-PS.23

Name of the group: Compulsory Courses of Master Study Specialisation Digital Business Engineering Requirement credits in the group: In this group you have to gain 30 credits Requirement courses in the group: In this group you have to complete 5 courses Credits in the group: 30

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
DA-DRS	Digital Risk And Security (DA-DRS) Michal Valenta	Z,ZK	6	30KP+30KC	Z	PS
DA-DMI	Data Mining Michal Valenta	Z,ZK	6	30KP+30KC	Z,L	PS
DD-DIN	Digital innovation Michal Valenta	ZK	6		Z	PS
DD-DSG	Digital strategy and governance Michal Valenta	ZK	6	2P+2C	Z	PS
DD-SMN	Strategic management Michal Valenta	ZK	6	4P+0C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NIE-DBE-PS.23 Name=Compulsory Courses of Master Study Specialisation Digital Business Engineering

DA-DRS Digit	al Risk And Security (DA-DRS)	Z,ZK	6
1 0	come crucial in the growth, sustainability and support of enterprises. However, the pervasive use of technologies also in		-
	errors and ommissions. The objective of this course is to understand and analyse IT related business risks and and h		
	risk management and security strategy and action plan. In the course, will first discuss the basics of IT Risk, Information		
	meworks to address them. Next, we will elaborate on the IT risk management and IT security functions in an organisati	-	-
	oth qualitative and quantitative. The theoretical knowledge will be applied in a group project, where students will condu	•	•
	results to the responsible managers. Guarantor and teacher: MSc. Steven De Haes, Ph.D.	uci a fisk assessii	ient in a real
		7 71/	0
	a Mining	Z,ZK	6
	ssed a huge increase in the amount of data being captured and stored. In these large datasets very useful knowledge is		
	th data mining techniques patterns are automatically revealed from such large datasets. First, data mining techniques		
• • • •	redictive and descriptive data mining techniques, with applications in marketing and risk management. Also, analyses		
0.1	nd Big Data will be looked at. Basic programming skills in Python will be learnt. The learned concepts, techniques and	programming lang	guage will be
	eal-life case. Teaching takes place at University of Antwerpen. See the web page		
	/study/programmes/all-programmes/digital-business-engineering/about-the-programme/study-programme/		
DD-DIN Digit	al innovation	ZK	6
This source features on innove	tion in the context of the digital, software-intensive economy. Starting from a broader perspective on innovation, both n	mainstream theorie	es and thinking
This course locuses on innova			
	native views from challengers, are discussed. This includes omnipresent innovation models in which IT-related innovati	ions are adopted b	by startups and
on innovation, as well as altern	native views from challengers, are discussed. This includes omnipresent innovation models in which IT-related innovati rones) and making them available in certain business domains, which requires agility and speed of development at the		
on innovation, as well as altern scaleups (eg. blockchains or di		e software level. A	lso, disruptive
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Name of the block: Elective vocational courses in the branch/specialization Minimal number of credits of the block: 0 The role of the block: VO

Code of the group: NIE-DBE-VO.23

Name of the group: Elective Vocational Courses for Master Specializations Except Digital Bussiness Engineering

Requirement credits in the group:

Requirement courses in the group:

Credits in the group: 0

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-ADM	Data Mining Algorithms Rodrigo Augusto Da Silva Alves, Pavel Kordík, Daniel Vašata Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-AIB	Algorithms of Information Security Martin Jure ek, Olha Jure ková, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-ADP	Architecture and Design patterns Jan Kurš, Jan Zimolka, Tomáš Chvosta, Ji í Borský, Filip K ikava Jan Kurš Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-AM1	Middleware Architectures 1 Tomáš Vitvar, Jaroslav Kucha Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-AM2	Middleware Architectures 2 Tomáš Vitvar, Jaroslav Kucha Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-BML	Bayesian Methods for Machine Learning Kamil Dedecius, Ond ej Tichý Ond ej Tichý Kamil Dedecius (Gar.)	КZ	5	2P+1C	L	VO
NI-BVS	Embedded Security Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	VO
NI-BKO	Error Control Codes Pavel Kubalík Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-DSV	Distributed Systems and Computing Pavel Tvrdík Jan Fesl Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-DDW	Web Data Mining Jaroslav Kucha, Milan Doj inovski Jaroslav Kucha Jaroslav Kucha (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-EPC	Effective C++ programming Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-GEN	Code Generators Petr Máj, Jan Janoušek Petr Máj Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	VO
NI-HWB	Hardware Security Ji í Bu ek Ji í Bu ek Ji í Bu ek (Gar.)	Z,ZK	5	2P+2C	L	VO
NI-KOD	Data Compression Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	VO
NI-MVI	Computational Intelligence Methods Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-MEP	Modelling of Enterprise Processes Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-MPJ	Modelling of Programming Languages Jan Vitek	Z,ZK	5	2P+1C	Z	VO
NI-MTI	Modern Internet Technologies Alexandru Moucha, Viktor erný Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	VO
NI-NSS	Normalized Software Systems Robert Pergl, Marek Suchánek, Jan Verelst Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	VO
NI-OSY	Operating Systems and Systems Programming Petr Zemánek, Tomáš Martinec Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-BUI	Business Informatics Petra Pavlí ková Petra Pavlí ková Petra Pavlí ková (Gar.)	Z,ZK	5	2P+2C	L	VO
NI-PIS	Enterprise Information Systems Martin Závrbský, Martin Mach, Vlastimil Jinoch, Martin Hasaj David Buchtela David Buchtela (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-KRY	Advanced Cryptology Róbert Lórencz, Ji í Bu ek Ji í Bu ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	VO

NI-PAS	Advanced Aspects of Business David Buchtela, St pánka Havlíková, Dominik Vítek, Ji í Maršál, Jana Soukupová, Zden k Ku era David Buchtela Zden k Ku era (Gar.)	Z,ZK	4	2P+1C	Z	VO
NI-PDB	Advanced Database Systems Michal Valenta, Yelena Trofimova Michal Valenta Michal Valenta (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-PDD	Data Preprocessing Marcel Ji ina Marcel Ji ina Marcel Ji ina (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	VO
NI-RUN	Runtime Systems Filip K ikava Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski, Jakub Klímek Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-SIM	Digital Circuit Simulation and Verification Martin Kohlik Martin Kohlik Martin Kohlik (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-SIB	Network Security Ji í Dostál, Martin Šutovský, Martin Holec, Simona Forn sek Simona Forn sek Ji í Dostál (Gar.)	Z,ZK	5	2P+1C	L	vo
NI-SCR	Statistical Analysis of Time Series Kamil Dedecius Kamil Dedecius (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-SBF	System Security and Forensics Simona Forn sek, Marián Svetlík Simona Forn sek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-DSS	Decision Support Systems Robert Pergl, Petra Pavlí ková, David Buchtela David Buchtela Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-TES	Systems Theory Stefan Ratschan, Ji í Vysko il Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-TSP	Testing and Reliability Petr Fišer Martin Da hel Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	VO
NI-TSW	Software Product Development Petra Pavlí ková Petra Pavlí ková Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	VO
NI-UMI	Artificial intelligence Pavel Surynek Pavel Surynek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-ESW	Embedded Software Miroslav Skrbek, Hana Kubátová Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-VCC	Virtualization and Cloud Computing Jan Fesl, Tomáš Vondra Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-APR	Selected Methods for Program Analysis Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-PON	Selected Topics in Optimization and Numerical mathematics St pán Starosta, Daniel Vašata, Karel Klouda Daniel Vašata Št pán Starosta (Gar.)	Z,ZK	5	2P+1C	L	VO
NI-VMM	Retrieval from Multimedia Tomáš Skopal, Ji í Novák Jaroslav Kucha Tomáš Skopal (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	VO

Characteristics of the courses of this group of Study Plan: Code=NIE-DBE-VO.23 Name=Elective Vocational Courses for Master Specializations Except Digital Bussiness Engineering

NI-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses on	algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the studer	nts should know n	nachine learning
basics. The emphasis is	put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation	systems) and mo	dels (e.g., kernel
methods).			
NI-AIB	Algorithms of Information Security	Z,ZK	5
Students will get acquai	nted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, st	udents will learn t	he mathematical
principles of cryptograp	nic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware dete	ction and the use	of machine
learning in detection sys	stems. The last topic includes practical steganographic methods and attacks on steganographic systems.		
NI-ADP	Architecture and Design patterns	Z,ZK	5
The objective of this cou	irse is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis	as well as with u	inderstanding of
the challenges, issues,	and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledg	e of object-orient	ed programming
and get familiar with the	commonly used object-oriented design patterns that represent the best practices for solving common software design problen	ns. In the second	part the students
will be introduced to the	principles of software architecture design and analysis. This includes the classical architectural styles, component based syste	ms, and some ad	vanced software
architectures used in la	ge-scale distributed systems.		
NI-AM1	Middleware Architectures 1	Z,ZK	5
Students will study new	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information sys	tem architecture,	web service
architecture and aplicati	on servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	d high availability
of applications.			
NI-AM2	Middleware Architectures 2	Z,ZK	5
Students will learn new	trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architec	tures, concepts a	nd technologies
for microservices, distru	buted cache and databases, smart contracts, realtime communication and web security.		

NI-BML Bayesian Methods for Machine Learning	KZ	5
The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In par		
models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning ab		
from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. Fo and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in m		
some of them.	euleai imaging. The siduents wi	in try to solve
NI-BVS Embedded Security	Z.ZK	5
Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implement	· · · · ·	-
and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart card		
of computer systems.		
NI-BKO Error Control Codes	Z,ZK	5
The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or	transmitted via channels.	
NI-DSV Distributed Systems and Computing	Z,ZK	5
Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time respon		
channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and m	echanisms that support high av	ailability of both
data and services, and safety in case of failures.	771/	<i></i>
NI-DDW Web Data Mining Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Stud	Z,ZK	5
techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also		
in the field of social web and recommendation systems.		
NI-EPC Effective C++ programming	Z,ZK	5
Students learn how to use the modern features of contemporary versions of the C++ programming language for software development.	1 7 1	-
and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and proces	ssor time requirements.	-
NI-EVY Efficient Text Pattern Matching	Z,ZK	5
Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are effici	ent in both access time and mer	mory complexity.
They will be able to use the knowledge in design of applications that utilize pattern matching.		
NI-FME Formal Methods and Specifications	Z,ZK	5
Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn	n to use some software tools the	at allow to prove
basic properties of software.		
NI-GEN Code Generators	Z,ZK	5
Advanced techniques of translating programs written in high-level programming languages are essential for understanding the field of s understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed		-
familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming language		ento will become
NI-GAK Graph theory and combinatorics	Z.ZK	5
	· · · ·	-
The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models	s and algorithms. The emphasis	will be not only
The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating funct		-
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NI-NON Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such m		
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implem		
as well as in parallel.	ient these algorithm	is sequentially
NI-NSS Normalized Software Systems	ZK	5
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engine	1	-
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related	-	
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called element	ts. These elements	provide the core
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the sta	ability and entropy-re	elated principles.
This knowledge allows students to realize new levels of evolvability in software architectures.		
NI-OSY Operating Systems and Systems Programming	Z,ZK	5
The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and ker		
process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The		
development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portation embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within		
focused on development of LINUX kernel modules.		work on projects
NI-BUI Business Informatics	Z,ZK	5
The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the area	1 1	-
ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT managed		-
of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Govern	nance, the importar	nce of ICT for
business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT managements and the context of information strategy with global business strategy.	nent, revenue and i	nvestment
management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).		
NI-PIS Enterprise Information Systems	Z,ZK	5
The course is focused on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage		
in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication		·
real examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the		
Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operation of the state of the	eration of informatio	n systems in the
company / organization.		
NI-KRY Advanced Cryptology	Z,ZK	5
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will have an evention of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will have an evention of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will have an evention of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will have an evention of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers.		
random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which the their own systems or to the creation of their own software solutions.	ey can apply to the i	niegration of
NI-PAS Advanced Aspects of Business	Z,ZK	4
The aim of the course is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run	1 1	-
management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related aspects.		
NI-PDB Advanced Database Systems	Z.ZK	5
NI-PDB Advanced Database Systems Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of data	Z,ZK abase machines (so	÷
	abase machines (so	called NoSQL
Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of data	abase machines (so	called NoSQL
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students will get familiar with lorenaic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forenaic analysis techniques and the importance of operating system/agenetics (security software) in the case of the system for track analysis and detection). NI-DSS Decision Support Systems Z,ZK 5 read motifies to provide software with knowledge or anticotion support systems, their classification (Powerora), software diversion support systems, software diversion support systems, software diversion methods and dispositions. Z,ZK 5 read motifies the analysis of each oriented decision support systems and the basies of distribution, optimization and exolution methods and algorithms. NI-DES Systems Theory Z,ZK 5 Software motifies and system software diversion system have bacceres critical. A key technique for mustaring this complexity is the usage of models that describe only hones access of the systems and for inclusion and exolution methods and algorithms that form the basis for the modeling and analysis of complex systems. Z,ZK 5 Students will gain knowledge orient for the task is hard, and automated to los for analyzing those models. This subject will present theory and algorithms that form the basis for the model system swith position and exolution methods and algorithms. Z,ZK 5 Students will gain knowledge orient is system sith of the design analysis of detain orient as an exolution the position of a given system show and the design analysis of detain orient as an exolution the system show and the design and allow methods and asseuts the system show and the design and allow		1	-
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Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technologies of the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development). NI-APR Selected Methods for Program Analysis Z,ZK 5 This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs. Z,ZK 5 NI-PON Selected Topics in Optimization and Numerical mathematics Z,ZK 5 The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical mathematics are explained too. Z,ZK 5 NI-VMM Retrieval from Multimedia Z,ZK 5 5 <td></td> <td>7.7K</td> <td>5</td>		7.7K	5
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Name of the block: Compulsory elective courses Minimal number of credits of the block: 20 The role of the block: PV

Code of the group: NIE-DBE-PVA.23

Name of the group: Compulsory Elective Courses for Master DBE Specialization A - Normalized Systems Theory

Requirement credits in the group: In this group you have to gain at least 5 credits (at most 9) Requirement courses in the group: In this group you have to complete 1 course Credits in the group: 5 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NIE-NSS	Normalized Software Systems Robert Pergl, Marek Suchánek, Jan Verelst Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	PV
DA-SEA	Software Engineering And Architecture Michal Valenta	Z,ZK	9	34F69G69S	Z,L	PV

Characteristics of the courses of this group of Study Plan: Code=NIE-DBE-PVA.23 Name=Compulsory Elective Courses for Master DBE Specialization A - Normalized Systems Theory

NIE-NSS	Normalized Software Systems	ZK	5			
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system						
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software						
architecture. In the seco	architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core					
functionality of information	on systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stab	ility and entropy-r	elated principles.			
This knowledge allows	students to realize new levels of evolvability in software architectures.					
DA-SEA	Software Engineering And Architecture	Z,ZK	9			
Basic software engineer	ing structures, practices, and patterns are explained in a realistic software engineering environment using the Java progarmmin	g language. Pract	ical assignments			
complement these lectu	complement these lectures. Basic software architecture structures, practices, and patterns are explained and discussed, including various aspects of evolvability. Video lectures and					
a practical assignment deepen this. Teaching takes place at University of Antwerpen. See the web page						
https://www.uantwerper	be/en/study/programmes/all-programmes/digital-business-engineering/about-the-programme/study-programme/					

Code of the group: NIE-DBE-PVB.23

Name of the group: Compulsory Elective Courses for Master Double degree Specialization DBE B - Engineering and Ethics

Requirement credits in the group: In this group you have to gain at least 3 credits (at most 6) Requirement courses in the group: In this group you have to complete at least 1 course (at most 2) Credits in the group: 3

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
DD-DSE	Data science and ethics Michal Valenta	ZK	3		Z	PV
DA-ESB	Ethical And Sustainable Business Michal Valenta	ZK	3	30KP	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NIE-DBE-PVB.23 Name=Compulsory Elective Courses for Master Double degree Specialization DBE B - Engineering and Ethics

DD-DSE	Data science and ethics	ZK	3			
Ethics tell us about right	and wrong. The course will provide an overview of key: (1) concepts, related to privacy, discrimination, transparency, and ex	plainability, (2) te	chniques to			
assess and improve on	these aspects, and (3) cautionary tales that motivate the importance thereof. The consideration of data science ethics is crud	cial for any data-d	Iriven company,			
as will be motivated by a	ample cautionary tales. With a wide range of cases, the large implications of new data science technologies on ethics will be	discussed. These	e include online			
tracking, medical record	s, Facebook data, Internet censorship, big data, privacy engineering, and Artificial Intelligence. Data scientists and business	managers are no	ot inherently			
unethical, but at the san	ne time not trained to think this through neither. This course aims to address this important gap. Students of a master double	degree specialisa	ation Digital			
Business Engineering w	rill attend this course during their stay at the partner university Antwerp					
DA-ESB	Ethical And Sustainable Business	ZK	3			
This course covers corp	orate responsibility, morality and sustainability. It has three main parts: Part 1: Ethics and morality in business History of ethic	s in business Ori	gins, stakeholder			
theory, basic philosophy Utilitarianism vs Kantian approaches Behavioural economic. Part 2: Corporate responsibility and sustainability in theory Shared value creation, social profit,						
social entrepreneurship Sustainable HR Circular Economy Green Deal and CSRD New business models for sustainability. Part 3: Corporate responsibility and sustainability in practice						
Implementing sustainability in the value chain of a company: products, operations, organisation and HR How to apply a management approach to sustainability. Teaching takes place						
at University Antwerpen. See the web page https://www.uantwerpen.be/en/study/programmes/all-programmes/digital-business-engineering/about-the-programme						

Code of the group: NIE-DBE-PV1.23

Name of the group: Compulsory Elective Courses for Master Specialization DBE - Modern Technology Requirement credits in the group: In this group you have to gain at least 5 credits (at most 25) Requirement courses in the group: In this group you have to complete at least 1 course (at most 5) Credits in the group: 5

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NIE-PDB	Advanced Database Systems Martin Svoboda Martin Svoboda (Gar.)	Z,ZK	5	2P+1C	Z	PV

DD-ZUM	Artificial Intelligence Fundamentals Pavel Surynek Pavel Surynek Pavel Surynek (Gar.)	Z,ZK	5	2P+2C	L	PV
NIE-BLO	Blockchain Róbert Lórencz, Josef Gattermayer, Marek Bielik, Jakub R ži ka Josef Gattermayer Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	Z	PV
NIE-AM1	Middleware Architectures 1 Tomáš Vitvar, Jaroslav Kucha , Milan Doj inovski Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	PV
NIE-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NIE-DBE-PV1.23 Name=Compulsory Elective Courses for Master Specialization DBE - Modern Technology

Specialization DB	E - Modern Technology							
NIE-PDB	Advanced Database Systems	Z,ZK	5					
Students orient themse	Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL							
databases), with the rel	ated new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CY	PHER, Gremlin).	The last part of					
the course deals with p	erformance evaluation of database machines. This course is equivalent to the course MIE-PDB.							
DD-ZUM	Artificial Intelligence Fundamentals	Z,ZK	5					
Students are introduced	to the fundamental problems in the Artificial Intelligence, and the basic methods for their solving. It focuses mainly on the clas	sical tasks from t	he areas of state					
space search, multi-age	ent systems, game theory, planning, and machine learning. Modern soft-computing methods, including the evolutionary algorit	hms and the neu	ral networks, will					
be presented as well. The	nis course is only for students of the double degree program with the University of Antwerp. Other students are not allowed to	enrol this course	, enrol the					
BIE-ZUM course instea	d.							
NIE-BLO	Blockchain	Z,ZK	5					
Students will understan	d the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain plat	forms. They will b	e able to design,					
code and deploy a secu	rre decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place	es an increased e	mphasis on the					
relationship between ble	ockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares t	he students for in	nplementing or					
supervising implementa	tion of blockchain-based solutions in both academia and business.							
NIE-AM1	Middleware Architectures 1	Z,ZK	5					
Students will study new	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information sys	tem architecture,	web service					
architecture and aplicati	on servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	d high availability					
of applications. This cou	irse replaces the course MIE-MDW.							
NIE-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5					
The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best								
practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic								
quality assurance.								

Code of the group: NIE-DBE-PVC.23

Name of the group: Compulsory Elective Courses for Master Specialization DBE C - Master Project Requirement credits in the group: In this group you have to gain at least 7 credits (at most 16) Requirement courses in the group: In this group you have to complete at least 1 course (at most 2) Credits in the group: 7 Note on the group: A FIT student who wants to complete two programs and obtain two degrees (Duble Degree

A FIT student who wants to complete two programs and obtain two degrees (Duble Degree DBE) must enroll in addition to the DA-IPR course (instead of NIE-MPR) enrolled in two other courses at the University of Anwerp: - Engineering & design science methodologies - Empirical research in MIS

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
DA-IPR	Integration project digital business engineering Michal Valenta	Z	9	30KP	L	PV
NIE-MPR	Master Project Zden k Muziká Zden k Muziká (Gar.)	Z	7		Z,L	PV

Characteristics of the courses of this group of Study Plan: Code=NIE-DBE-PVC.23 Name=Compulsory Elective Courses for Master Specialization DBE C - Master Project

DA-IPR	Integration project digital business engineering	Z	9		
This is typically a study	followed by a thesis. Teaching takes place at University Antwerpen. Contact Information: Jan Verelst jan.verelst@uantwerper	be Dieter Van Nu	uffel		
dieter.vannuffel@uantwe	rpen.be See the web page https://www.uantwerpen.be/en/study/programmes/all-programmes/digital-business-engineering/about-	the-programme/st	tudy-programme/		
NIE-MPR	Master Project	Z	7		
1. At the beginning of th	e semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial	tasks that should	be carried out		
during the semester. If the	ne requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the er	nd of the semeste	r. 2. The external		
supervisor enters the in	formation on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.	cz/student/studijn	i/formulare). The		
completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic that the student has reserved					
is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and					
approvable at the end of the semester.					
approvable at the end o	the semester.				

Name of the block: Elective courses Minimal number of credits of the block: 0 The role of the block: V Code of the group: NIE-DBE-V-ANT Name of the group: Elective courses from University of Antverpen Requirement credits in the group: Requirement courses in the group: Credits in the group: 0 Note on the group: Any courses offered by the University of Antwerpen during stay there

Codo of the arrest						
Code of the grou	•					
0	up: Purely elective master's courses					
Requirement cre	•					
Credits in the gro	irses in the group:					
Note on the grou	•					
	P. Name of the course / Name of the group of courses					
Code	(in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NIE-BLO	Blockchain Róbert Lórencz, Josef Gattermayer, Marek Bielik, Jakub R ži ka Josef Gattermayer Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	z	V
NIE-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	3P+1C	Z	V
NIE-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NIE-MVI	Computational Intelligence Methods Pavel Kordík, Miroslav epek Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-ARI	Computer arithmetic Pavel Kubalík Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NIE-SCE1	Computer Engineering Seminar Master I Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	Z	V
NIE-SCE2	Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L	V
NI-DSW	Design Sprint Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	V
NI-DID	Digital drawing Denisa Nová ková, Eliška Novotná Denisa Nová ková Denisa Nová ková (Gar.)	Z	2	4C	Z,L	V
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GRI	Grid Computing André Sopczak, Petr Fiedler Pavel Tvrdík André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-HMI	History of Mathematics and Informatics Alena Šolcová Alena Šolcová Alena Šolcová (Gar.)	Z,ZK	3	2P+1C	Z	V
NIE-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
FITE-EHD	Introduction to European Economic History Tomáš Evan	Z,ZK	3	2P+1C	L	V
MIE-MZI	Mathematics for data science Št pán Starosta	Z,ZK	4	2P+1C	L	V
NIE-AM2	Middleware Architectures 2 Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-OSY	Operating Systems and Systems Programming Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-PAM	Parameterized Algorithms Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-ROZ	Pattern Recognition Michal Haindl Michal Haindl (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-PML	Personalized Machine Learning Rodrigo Augusto Da Silva Alves Karel Klouda Rodrigo Augusto Da Silva Alves (Gar.)	Z,ZK	5	2P+1C	z	V
NI-AML	Advanced machine learning Rodrigo Augusto Da Silva Alves, Zden k Buk, Miroslav epek, Petr Šimánek, Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)	Z,ZK	5	2P + 1C	L	V
NIE-PDL	Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)	KZ	5	2P+1C	Z	V

FIT-ACM1	Programming Practices 1 Tomáš Valla	KZ	5	4C	L	V
FIT-ACM2	Programming Practices 2 Ond ej Suchý	KZ	5	4C	Z	V
FIT-ACM3	Programming Practices 3 Ond ej Suchý	KZ	5	4C	L	V
FIT-ACM4	Programming Practices 4 Ond ej Suchý	KZ	5	4C	Z	V
FIT-ACM5	Programming Practices 5	KZ	5	4C	L	v
FIT-ACM6	Ond ej Suchý Programming Practices 6	KZ	5	4C	L	v
NIE-VPR	Ond ej Suchý Research Project	Z	5		Z,L	v
NIE-SWE	Št pán Starosta Št pán Starosta Št pán Starosta (Gar.) Semantic Web and Knowledge Graphs	Z,ZK	5	2P+1C	_,_ Z	v
MI-SCE1	Milan Doj inovski Milan Doj inovski Milan Doj inovski (Gar.) Computer Engineering Seminar Master I	Z	4	2C	L,Z	v
	Hana Kubátová Side-Channel Analysis in Hardware		-			
NIE-HSC	Vojt ch Miškovský, Petr Socha Vojt ch Miškovský Vojt ch Miškovský (Gar.) Web Data Mining	Z,ZK	4	2P+2C	Z	V
NIE-DDW	Milan Doj inovski Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-BPS	Wireless Computer Networks Alexandru Moucha Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-SEP	World Economy and Business Tomáš Evan	Z,ZK	4	2P+1C	Z	V
FITE-SEP	World Economy and Business <i>Tomáš Evan</i>	Z,ZK	4	2P+2C	Z	v
NIE-BLO BI Students will understand the code and deploy a secure of	e courses of this group of Study Plan: Code=NIE-V.21 Name=Pu ockchain e foundations of blockchain technology, smart contract programming, and gain an overvie decentralized application, and assess whether integration of a blockchain is suitable for a	ew of most notabl a given problem.	e blockchai The course	│ Z n platforms.⊺ places an in	Z,ZK	hasis on the
-	chains and information security. It is concluded with a defense of a research or applied s of blockchain-based solutions in both academia and business.	emester project,	which prepa	ares the stuc	lents for impl	ementing or
NIE-SWE Se	emantic Web and Knowledge Graphs				,ZK	5
	most recent concepts and technologies of the Semantic Web. The course will provide ar gration, publishing, querying and consumption of semantic data. The students will also				•	
quality assurance.	omplexity Theory			7	,ZK	5
Students will learn about the	e fundamental classes of problems in the complexity theory and different models of algo	oritms and about	implications		·	-
	omputability			Z	,ZK	4
	e functions and effective computability.					
	omputational Intelligence Methods e basic methods and techniques of computational intelligence, which are based on tradi	itional artificial int	telligence, a		,ZK	5 are applicable
	roblems. The subject is also devoted to modern neural networks and the ways in which th n to problems related to data extraction, management, intelligence in games and optimis	,	roevolution.	Students wil	ll learn how th	nese methods
	omputer arithmetic			Z	,ZK	4
	data representations used in digital devices and will be able to design arithmetic operati	ons implementati	ion units.		· I	
The Seminar of Computer E	omputer Engineering Seminar Master I Engineering is a (s)elective course for students who want to deal with deeper topics of digit within the subject. Each student or group of students solves some interesting topic with	-	-			
	nal literature and/or work in K N laboratories. The capacity of the subject is limited by the	ne possibilities of	the semina	r teachers. T	he topics are	new for each
NIE-SCE2 Co	omputer Engineering Seminar Master II				Z	4
	Engineering is a (s)elective course for students who want to deal with deeper topics of digi within the subject. Each student or group of students solves some interesting topic with	-	-			
	nal literature and/or work in K N laboratories. The capacity of the subject is limited by th			-		
NI-DSW De	esign Sprint	mo ore obt- t-	from 1-1-	to volidate -	Z	2 E dovio During
the course the students will	cts using the Design Sprint method, developed by Google. THanks to this method the tea get familiar with the method as participants. Through practical challenges they will try th	-		-		
testing the prototypes (plus NI-DID Di	final presentation). gital drawing				Z	2
The course will introduce st	udents to the basic principals of digital drawing and graphical design. Students will gain	-	-		ve and color	theory, which
	their own design works. Students will also gain experience in drawing and painting with ad painting. The course is organized as a thematic practices covering parts of theory and	-	-		-	vno wants to
NIE-EVY Ef	ficient Text Pattern Matching	· · · · · · · · · · · · · · · · · · ·		Z	,ZK	5
	efficient algorithms for text pattern matching. They learn to use so called succinct data stru knowledge in design of applications that utilize pattern matching.	ictures that are ef	ficient in bo	th access tim	ne and memo	ry complexity.
	ames and reinforcement learning earning is very hot recently, because of advances in deep learning, recurrent neural net	works and gener	al artificial in		,ZK	4
	id practical background so you can participate in related research activities. Presented i	-				

NI-GRI Grid Computing	Z,ZK	5
Grid computing and gain knowledge about the world-wide network and computing infrastructure.	7 71/	2
NIE-HMI History of Mathematics and Informatics The course focuses on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer	Z,ZK science The topic	3 s are selected
for finding some relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science		
NIE-DVG Introduction to Discrete and Computational Geometry	Z,ZK	5
The course intends to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	with the most func	amental notions
FITE-EHD Introduction to European Economic History	Z,ZK	3
The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global e	· ·	the description
of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the econom area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial inst	-	-
does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and		
meetings will consist of a mixture of lecture and discussion.		
MIE-MZI Mathematics for data science	Z,ZK	4
In this course, the students are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used i include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality printing and the standard methods) and algorithms used in the standard methods		-
selected notions from probability theory and statistics.		
NIE-AM2 Middleware Architectures 2	Z,ZK	5
Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architect for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.	tures, concepts a	nd technologies
NIE-OSY Operating Systems and Systems Programming	Z,ZK	5
This course is focused on the design and implementation of the basic components that make up modern operating systems. This includes threads, pr		
memory, system calls, interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating system arc	hitecture with emp	hasis on the
kernel architecture. Within the course, they will gain practical experience with the development of a small but fully functional operating system. NIE-PAM Parameterized Algorithms	7.74	4
NIE-PAM Parameterized Algorithms There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often nece	Z,ZK ssary to solve the	-
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often	-	-
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity explored a base with the input size of the time complexity explored a base of time complexity explored a base		
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomia which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solut		
plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.		
NIE-SYP Parsing and Compilers	Z,ZK	5
The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.	or various variants	and applications
NIE-ROZ Pattern Recognition	Z,ZK	5
The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the s		
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, an NIE-PML Personalized Machine Learning	Z,ZK	aspects. 5
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteris	· · ·	-
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal inte		
to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from the perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.	eoretical, algorithn	nic, and practical
NI-AML Advanced machine learning	Z,ZK	5
The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of	I ' I	-
processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the		
NIE-PDL Practical Deep Learning This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine	KZ	5 rk Throughout
the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields su		
language processing.		
FIT-ACM1 Programming Practices 1	KZ	5
This is a selective course for preparing talented student for representation in international programming contests. FIT-ACM2 Programming Practices 2	KZ	5
FIT-ACM2 Programming Practices 2 This is a selective course for preparing talented student for representation in international programming contests.	κ <u>z</u>	5
FIT-ACM3 Programming Practices 3	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM4 Programming Practices 4	KZ	5
This is a selective course for preparing talented student for representation in international programming contests. FIT-ACM5 Programming Practices 5	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.		5
FIT-ACM6 Programming Practices 6	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.		
NIE-VPR Research Project 1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial	Z	5 be carried out
during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the		
Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the	e courses BIE-BA	P, MIE-MPR,
MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the be		
the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the he for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student fo		-
aim at fine-tuning the ET topic so that the ETT will be complete and approvable at the end of the semester.		

MI-SCE1	Computer Engineering Seminar Master I	Z	4			
The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students						
are approached individu	ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of t	he subject is wor	k with scientific			
articles and other profes	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tead	chers. The topics a	are new for each			
semester.						
NIE-HSC	Side-Channel Analysis in Hardware	Z,ZK	4			
This course is dedicated	t to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical atta	cks. Students get	familiar with			
various kinds of side cha	annels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks ar	nd get familiar with	n higher-order			
attacks. They also get p	ractice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel inform	ation leakage.				
NIE-DDW	Web Data Mining	Z,ZK	5			
Students will learn lates	t methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain	an overview of W	leb mining			
techniques for Web craw	ling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an over	rview of most rece	ent developments			
in the field of social web	and recommendation systems.					
NIE-BPS	Wireless Computer Networks	Z,ZK	4			
Students will learn about	t the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in	ad-hoc networks,	multicast and			
broadcast mechanisms,	and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get know	wledge of security	/ mechanisms			
for wireless networks ar	d get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.					
NIE-SEP	World Economy and Business	Z,ZK	4			
The course introduces s	students of technical university to the international business. It does that predominantly by comparing individual countries and	d key regions of w	orld economy.			
Students get to know at	bout different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedor	n, corruption and	economic			
development, which are	needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on in	idividual readings	. It is advised to			
take bachelor level of this course BIE-SEP as a prerequisite.						
FITE-SEP	World Economy and Business	Z,ZK	4			
The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy.						
Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic						
development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to						
take bachelor level of this course BIE-SEP as a prerequisite.						
-						

List of courses of this pass:

Code	Name of the course	Completion	Credits			
DA-DMI	Data Mining	Z,ZK	6			
In the past decade,	weve witnessed a huge increase in the amount of data being captured and stored. In these large datasets very useful knowledge is pr	esent, though ofter	n concealed			
in the vastness of	the data. With data mining techniques patterns are automatically revealed from such large datasets. First, data mining techniques an	d applications are	discussed.			
Next, we will go int	to popular predictive and descriptive data mining techniques, with applications in marketing and risk management. Also, analyses suc	ch as social netwo	rk analysis,			
text mining, proce	iss mining, and Big Data will be looked at. Basic programming skills in Python will be learnt. The learned concepts, techniques and pr	ogramming langua	age will be			
	applied and evaluated with a real-life case. Teaching takes place at University of Antwerpen. See the web page					
	https://www.uantwerpen.be/en/study/programmes/all-programmes/digital-business-engineering/about-the-programme/study-prog					
DA-DRS	Digital Risk And Security (DA-DRS)	Z,ZK	6			
	ogy has become crucial in the growth, sustainability and support of enterprises. However, the pervasive use of technologies also incur					
	rrime, fraud, errors and ommissions. The objective of this course is to understand and analyse IT related business risks and and how					
	nformation risk management and security strategy and action plan. In the course, will first discuss the basics of IT Risk, Information Security strategy and action plan.		•			
	rds and frameworks to address them. Next, we will elaborate on the IT risk management and IT security functions in an organisation.	-	-			
to risk assessmer	nt methods, both qualitative and quantitative. The theoretical knowledge will be applied in a group project, where students will conduct	t a risk assessmer	nt in a real			
	organisation, and present the results to the responsible managers. Guarantor and teacher: MSc. Steven De Haes, Ph.D.					
DA-ESB	Ethical And Sustainable Business	ZK	3			
	corporate responsibility, morality and sustainability. It has three main parts: Part 1: Ethics and morality in business History of ethics in	•				
	sophy Utilitarianism vs Kantian approaches Behavioural economic. Part 2: Corporate responsibility and sustainability in theory Share		•			
	ship Sustainable HR Circular Economy Green Deal and CSRD New business models for sustainability. Part 3: Corporate responsibilit					
	ainability in the value chain of a company: products, operations, organisation and HR How to apply a management approach to susta sity Antwerpen. See the web page https://www.uantwerpen.be/en/study/programmes/all-programmes/digital-business-engineering/at		•			
DA-IPR	Integration project digital business engineering	Z	9			
	Ily a study followed by a thesis. Teaching takes place at University Antwerpen. Contact Information: Jan Verelst jan.verelst@uantwerp ntwerpen.be See the web page https://www.uantwerpen.be/en/study/programmes/all-programmes/digital-business-engineering/about-the-					
DA-SEA	Software Engineering And Architecture	Z,ZK	9			
, i i i i i i i i i i i i i i i i i i i	neering structures, practices, and patterns are explained in a realistic software engineering environment using the Java progarmming la		•			
complement these	e lectures. Basic software architecture structures, practices, and patterns are explained and discussed, including various aspects of e a practical assignment deepen this. Teaching takes place at University of Antwerpen. See the web page	volvability. video le	clures and			
	https://www.uantwerpen.be/en/study/programmes/all-programmes/digital-business-engineering/about-the-programme/study-prog	ramme/				
DD-DIN	Digital innovation	ZK	6			
	s on innovation in the context of the digital, software-intensive economy. Starting from a broader perspective on innovation, both mai		-			
	vell as alternative views from challengers, are discussed. This includes omnipresent innovation models in which IT-related innovations					
scaleups (eg. blockchains or drones) and making them available in certain business domains, which requires agility and speed of development at the software level. Also, disruptive						
innovation, where existing value chains are challenged, is discussed with its requirement for new levels of productivity in software development. Leading theories are discussed and						
illustrated with local and international cases using guest lectures. Students of a master double degree specialisation Digital Business Engineering will attend this course during their						
	stay at the partner university Antwerp.					
L						

	Data science and ethics	ZK	3
	ut right and wrong. The course will provide an overview of key: (1) concepts, related to privacy, discrimination, transparency, and exp		-
	e on these aspects, and (3) cautionary tales that motivate the importance thereof. The consideration of data science ethics is crucial		
	d by ample cautionary tales. With a wide range of cases, the large implications of new data science technologies on ethics will be dis		
-	records, Facebook data, Internet censorship, big data, privacy engineering, and Artificial Intelligence. Data scientists and business net intermed to think this through neither. This course aims to address this important gap. Students of a master double c	-	-
unetinical, but at	Business Engineering will attend this course during their stay at the partner university Antwerp	legree specialisation	on Digital
DD-DSG	Digital strategy and governance	ZK	6
	es a complete and comprehensive overview of what digital governance entails and how it can be applied in practice. The course is or		
	: concepts and practices of digital governance, the impact of digital governance on business/IT strategic and operational alignment, a	-	-
	e is based on the teacher's knowledge obtained in applied research projects on the relationship between digital governance practice		-
the student in uno	lerstanding and absorbing the material provided, the course uses short assignments and case studies. Students of a master double	degree specialisat	ion Digital
	Business Engineering will attend this course during their stay at the partner university Antwerp		
DD-SMN	Strategic management	ZK	6
In the first part of t	ne course, the different concepts and perspectives of strategic management are analyzed. The basic characteristics of strategic think	king are being anal	yzed. Then
	ission/vision, as the starting point in strategic thinking, is being discussed. This is being linked to the broader concept of sustainability /		
	s focus on the three basic dimensions of strategy: (1) the strategy content: business level strategy, corporate level strategy, and network		
-	prmation, strategic change, and strategic innovation, (3) the strategy context: the industry context, the organizational context, and the		
	pters, the fundamental strategic management paradoxes are situated and evaluated in the strategic management theory. Attention is which can be used to manage the strategy process. Students of a master double degree specialisation Digital Business Engineering	-	-
management tools	their stay at the partner university Antwerp		arse during
DD-ZUM	Artificial Intelligence Fundamentals	Z,ZK	5
_	iced to the fundamental problems in the Artificial Intelligence, and the basic methods for their solving. It focuses mainly on the classica	·	-
	agent systems, game theory, planning, and machine learning. Modern soft-computing methods, including the evolutionary algorithms		
	well. This course is only for students of the double degree program with the University of Antwerp. Other students are not allowed to		
	BIE-ZUM course instead.		
FIT-ACM1	Programming Practices 1	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM2	Programming Practices 2	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM3	Programming Practices 3	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM4	Programming Practices 4	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM5	Programming Practices 5	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM6	Programming Practices 6	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FITE-EHD	Introduction to European Economic History	Z,ZK	3
	ces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global eco		
, , ,	in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic	, 0	
	pire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial instituti ailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and o	-	
	meetings will consist of a mixture of lecture and discussion.	iganizations in his	
FITE-SEP			tory. Class
	World Economy and Business	7 7K	
	World Economy and Business	Z,ZK ev regions of world	4
Students get to	World Economy and Business ces students of technical university to the international business. It does that predominantly by comparing individual countries and know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom	ey regions of world	4 economy.
•	ces students of technical university to the international business. It does that predominantly by comparing individual countries and k	ey regions of world n, corruption and e	4 d economy. economic
•	ices students of technical university to the international business. It does that predominantly by comparing individual countries and k know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom	ey regions of world n, corruption and e	4 d economy. economic
s	nces students of technical university to the international business. It does that predominantly by comparing individual countries and k know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom In are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on indiv	ey regions of world n, corruption and e	4 d economy. economic
development, whic MI-SCE1	nces students of technical university to the international business. It does that predominantly by comparing individual countries and k show about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom in are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on indiv take bachelor level of this course BIE-SEP as a prerequisite.	ey regions of world n, corruption and e idual readings. It is Z	4 d economy. economic s advised to 4
development, whic MI-SCE1 The Seminar of Cor	Inces students of technical university to the international business. It does that predominantly by comparing individual countries and k show about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom on are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on indiv take bachelor level of this course BIE-SEP as a prerequisite. Computer Engineering Seminar Master I	ey regions of world n, corruption and e idual readings. It is Z pfailures and attact	4 economy. conomic s advised to 4 ks. Students
development, whic MI-SCE1 The Seminar of Cor are approached in	In the selected supervisor. Part of the constance to the subject is limited by the possibilities of the seminar teacher for the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the constant of the subject is limited by the possibilities of the seminar teacher for the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for the constant of the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher for the subject is limited by the possibilities of the seminar teacher for teacher fo	ey regions of world n, corruption and e idual readings. It is Z failures and attact subject is work wi	4 d economy. sconomic s advised to 4 ks. Students th scientific
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NI-AM1	Middleware Architectures 1	Z,ZK	5
	dy new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system		
architecture and ap	lication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm of applications.	nunications and high	availability
NI-AM2	Middleware Architectures 2	Z,ZK	5
	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture	I ' I	-
	for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.	-	-
NI-AML	Advanced machine learning	Z,ZK	5
	ices students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of rec	-	-
	control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with		
NI-APR	Selected Methods for Program Analysis uces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynar	Z,ZK	5 ic Analysis
	art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimization		
	Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.		
NI-BKO	Error Control Codes	Z,ZK	5
-	al of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transr		
NI-BML	Bayesian Methods for Machine Learning	KZ	5
-	sed on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden		
	ations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a		
	will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging.		
	some of them.		
NI-BUI	Business Informatics	Z,ZK	5
	rse is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of b architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL_COBIT) in IT managements are as a standard standar	-	-
	architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manageme Ind resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governan	-	-
	e context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT manageme	-	
	management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).		
NI-BVS	Embedded Security	Z,ZK	5
-	c knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of crypto		
and software (in en	nbedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources of computer systems.	s for securing intern	al functions
NI-DDW	Web Data Mining	Z.ZK	5
	arn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain	I ' I	-
techniques for Web	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overvie	w of most recent de	velopments
	in the field of social web and recommendation systems.		
NI-DID	Digital drawing	Z	2
	roduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, persp y apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course		
	r learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practi	-	
NI-DSS	Decision Support Systems	Z,ZK	5
The aim of the cou	rse is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of	data-oriented, mod	lel-oriented
-	ented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will		e principles
	conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods a		
NI-DSV Students are introd	Distributed Systems and Computing uced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing	Z,ZK	5 munication
	rn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that s	•	
,	data and services, and safety in case of failures.		,
NI-DSW	Design Sprint	Z	2
	on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to valida		
the course the st	udents will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting wit testing the prototypes (plus final presentation).	n research and finis	sning with
NI-EHW	Embedded Hardware	Z,ZK	5
	s basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the		
systems, that profi	t from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed,	including standardi	zed means
	of internal communication, parallelism extraction and utilization in special structures and system architectures.		
NI-EPC	Effective C++ programming	Z,ZK	5
	v to use the modern features of contemporary versions of the C++ programming language for software development. The course focu ficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor		g effectivity
NI-ESW	Embedded Software	Z,ZK	5
	e course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the ba	I ' I	
	d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, u		
··· ·	combined with artificial intelligence.	· · · · ·	
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
Succents get Knowl	ledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acces They will be able to use the knowledge in design of applications that utilize pattern matching.	s ame and memory	complexity.
NI-FME	Formal Methods and Specifications	Z,ZK	5
	to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some so		
	basic properties of software.		-
NI-GAK	Graph theory and combinatorics	Z,ZK	5
, a	iss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms.	•	
i on undestanding th	e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top	nes norn graph and	nypergraph

coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory will be also applied in the fields of combinatorics on words, formal languages and bioinformatics.

	of combinatorics on words, formal languages and bioinformatics.		
NI-GEN	Code Generators	Z,ZK	5
	ques of translating programs written in high-level programming languages are essential for understanding the field of systems program		-
understanding the	algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems progra	•	will become
NI-GLR	familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming lang		4
	Games and reinforcement learning recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen	Z,ZK	1
The held of reinio	give you both theoretical and practical background so you can participate in related research activities. Presented in English		intended to
NI-GPU	GPU Architectures and Programming	Z,ZK	5
	knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUI		1
-	widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com		
	will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.		
NI-GRI	Grid Computing	Z,ZK	5
	Grid computing and gain knowledge about the world-wide network and computing infrastructure.		
NI-HWB	Hardware Security	Z,ZK	5
-	es the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguard	-	-
-	neans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studen	-	edge about
NI-KOD	yptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions	Z,ZK	5
	Data Compression Data Compression Data Compression		-
	he overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stude	•	•
	lossy data compression methods used in image, audio, and video compression.		
NI-KRY	Advanced Cryptology	Z,ZK	5
Students will lear	n the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the	he mathematical p	rinciples of
random number	generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they c	an apply to the inte	egration of
	their own systems or to the creation of their own software solutions.		
NI-MCC	Multicore CPU Computing	Z,ZK	5
•	cquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on mu	•	
-	red memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowled iques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and	-	
optimization techn	On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.	memory intenace	unougriput.
NI-MEP	Modelling of Enterprise Processes	Z,ZK	5
	focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approa	,	-
	implementation of processes, organisation structures and information support in big enterprises and institutions.		0
NI-MKY	Mathematics for Cryptology	Z,ZK	5
	Mathematics for Cryptology deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In		1
Students will gain	deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discret	particular, the cour te logarithm. The p	rse focuses
Students will gain on the problem of	deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discret factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on	particular, the cour te logarithm. The p lattices.	rse focuses problem of
Students will gain on the problem of NI-MPJ	deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discret factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on Modelling of Programming Languages	particular, the count te logarithm. The p lattices. Z,ZK	rse focuses problem of 5
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	focused on development of LINUX kernel modules.			
NI-PAS	Advanced Aspects of Business	Z,ZK	4	
The aim of the co	burse is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run the		or business	
	management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related		F	
NI-PDB	Advanced Database Systems emselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of databas	Z,ZK		
	he related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPH			
	the course deals with performance evaluation of database machines.		o laot part of	
NI-PDD	Data Preprocessing	Z,ZK	5	
	repare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data s	1 '	-	
	and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteris		-	
	pages.		1	
NI-PIS	Enterprise Information Systems	Z,ZK	5	
	sed on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of b			
	telligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication			
-	thermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the bus			
Students will be ac	equainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operatio company / organization.	n or mormation s	ystems in the	
NI-PON	Selected Topics in Optimization and Numerical mathematics	Z,ZK	5	
-	s on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of co		1	
	ematics for informatics. The methods are explained and described along with the details on how they are implemented on computers			
searce main	of numerical matematics, mainly numerical linear algebra, are explained too.			
NI-REV	Reverse Engineering	Z,ZK	5	
	cquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens bef		-	
-	s will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedic			
	tten in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be d			
debuggers and de	ebugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer	malware scene.	The focus of	
	the course is on the seminars, where students will solve practically oriented tasks from the real world.			
NI-RUN	Runtime Systems	Z,ZK	5	
This course is an in-	troduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experience	e in design and im	plementation	
-	d a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compil		-	
Just-in-time compile	ation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementation	ons of real-world V	Ms, including	
	Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs	1	1	
NI-SBF	System Security and Forensics	Z,ZK	5	
-	familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentical			
students will get fa	miliar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forens importance of operating system/operating system artifacts or file system for attack analysis and detection).	ic analysis technic	ques and the	
		7 71/		
NI-SCR	Statistical Analysis of Time Series	Z,ZK	5	
The course deals	Statistical Analysis of Time Series with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices	s, employment) ar	5 5 d industrial	
The course deals problems (modellin	Statistical Analysis of Time Series with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conve	s, employment) ar	5 5 d industrial 5 del, estimate	
The course deals problems (modellin its parameters, ana	Statistical Analysis of Time Series with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conve alyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the ma	s, employment) ar enient process mo in principles base	5 nd industrial del, estimate d on practica	
The course deals problems (modellin its parameters, ana	Statistical Analysis of Time Series with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conve	s, employment) ar enient process mo in principles base	5 nd industrial del, estimate d on practica	
The course deals problems (modellin its parameters, ana real-world example	Statistical Analysis of Time Series with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conver- alyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the ma- se. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfe the academic to the real world.	s, employment) ar enient process mo in principles based er of students' kno	5 nd industrial del, estimate d on practica	
The course deals problems (modellin its parameters, ana real-world example NI-SIB	Statistical Analysis of Time Series with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices and of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conver- alyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the ma es. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transf the academic to the real world. Network Security	s, employment) ar enient process mo in principles based er of students' kno Z,ZK	5 nd industrial del, estimate d on practica owledge from 5	
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performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the nanagement of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration

	and development tools (Continuous integration and development).	The use of model	rincgration
NI-VMM	Retrieval from Multimedia	Z,ZK	5
	general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feat	, ,	-
	objects, indexing, and structure of distributed search engines.		
NIE-AM1	Middleware Architectures 1	Z,ZK	5
1	y new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syste	, ,	1
architecture and apl	ication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm	unications and hig	h availability
	of applications. This course replaces the course MIE-MDW.		
NIE-AM2	Middleware Architectures 2	Z,ZK	5
Students will learn	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture	es, concepts and te	echnologies
	for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.		
NIE-ARI	Computer arithmetic	Z,ZK	4
	Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementa		
NIE-BLO	Blockchain	Z,ZK	5
	stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platform		-
	secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places a	•	
relationship betwee	en blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the supervising implementation of blockchain-based solutions in both academia and business.	students for imple	emenung or
NIE-BPS	Wireless Computer Networks	Z.ZK	4
-	about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad	, ,	-
	isms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowle		
	for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitab	ble tools.	
NIE-CPX	Complexity Theory	Z,ZK	5
1	about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	, ,	g practical
	(in)tractability of difficult problems.		
NIE-DDW	Web Data Mining	Z,ZK	5
Students will lea	rn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain	an overview of We	b mining
techniques for Web	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overvie	w of most recent de	evelopments
	in the field of social web and recommendation systems.		
NIE-DIP	Diploma Thesis	Z	30
NIE-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The course intends	to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with	the most fundame	ental notions
	of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	7 71/	-
NIE-EVY	Efficient Text Pattern Matching		
		Z,ZK	5
	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acces		-
Students get knowle	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acces. They will be able to use the knowledge in design of applications that utilize pattern matching.	s time and memory	complexity.
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This course is focu	Operating Systems and Systems Programming	Z,ZK	5
	sed on the design and implementation of the basic components that make up modern operating systems. This includes threads, proce	, 0	,
memory, system	calls, interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating system archite		sis on the
	kernel architecture. Within the course, they will gain practical experience with the development of a small but fully functional operating	<u> </u>	4
NIE-PAM	Parameterized Algorithms optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necess	Z,ZK	4 probleme
	. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one	•	•
	inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponent		
	n the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial tim		
	sible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solutio		
plethora of param	eterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (pre	esumably) does no	t exist. We
	will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation	n schemes.	
NIE-PDB	Advanced Database Systems	Z,ZK	5
	emselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database		
databases), with th	ne related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPH	IER, Gremlin). The	last part of
	the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PDB.		
NIE-PDL	Practical Deep Learning	KZ	5
	signed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine lea ts will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such a	-	-
the course, studen	Is will develop practical skills in building and training deep neural networks, using Fytorich to solve real-world problems in neids such a language processing.	as computer vision	anu naturai
NIE-PDP	Parallel and Distributed Programming	Z,ZK	6
	mputer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores		-
	biguitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platfor		-
-	es of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication oper	-	
	parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on		°
learn the technique	es of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course	includes a semeste	er project of
	practical programming in OpenMP and MPI for solving a particular nontrivial problem.		
NIE-PML	Personalized Machine Learning	Z,ZK	5
	chine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristic		
	is commonly used in applications such as recommender systems, which recommend items to users based on their personal interest		
to a wide range of o	ther fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theore	-	nd practical
	perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial commu		
NIE-ROZ	Pattern Recognition	Z,ZK	5
	nodule is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the sta		
-	Idents will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, ar		-
NIE-SCE1	Computer Engineering Seminar Master I mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to	Z failures and attack	4 s Students
	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the		
	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher		
	semester.		
NIE-SCE2			
		Z	4
	Computer Engineering Seminar Master II mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to	- 1	4
The Seminar of Co	Computer Engineering Seminar Master II	failures and attack	4 s. Students
The Seminar of Co are approached in	Computer Engineering Seminar Master II mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to	failures and attack subject is work wit	4 s. Students h scientific
The Seminar of Co are approached in articles and other p	Computer Engineering Seminar Master II mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher semester.	o failures and attack subject is work wit s. The topics are n	4 s. Students h scientific
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The Seminar of Co are approached ir articles and other p NIE-SEP The course introd Students get to development, whice NIE-SWE The students will	Computer Engineering Seminar Master II mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the borofessional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher semester. World Economy and Business uces students of technical university to the international business. It does that predominantly by comparing individual countries and k know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom of the subject for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual take bachelor level of this course BIE-SEP as a prerequisite. Semantic Web and Knowledge Graphs learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies of the Semantic Web.	b failures and attack subject is work wit 's. The topics are n Z,ZK ey regions of world n, corruption and e idual readings. It is Z,ZK hnologies, methods	4 ss. Students h scientific ew for each 4 economy. conomic advised to 5 s and best
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