Study plan

Name of study plan: Master Programme Informatics, unspecified Specialization, in English, 2021

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: 63 Elective courses credits: 57 Sum of credits in the plan: 120 Note on the plan: This version of the study plan is intended for students who have been admitted to study from the academic year 2024/2025 to the full-time form of the Master's degree programme, when applicants are admitted to study in the degree programme and choose a specialisation later. In addition to credits for compulsory courses of the programme, the student must obtain all credits for the compulsory courses of spacialisation in which he or she intends to profile during the study. In total, he or she must obtain a minimum of 120 credits.

Name of the block: Compulsory courses in the program Minimal number of credits of the block: 63 The role of the block: PP

Code of the group: NIE-PP.21

Name of the group: Compulsory Courses of Master Study Program, Version 2021 Requirement credits in the group: In this group you have to gain 63 credits Requirement courses in the group: In this group you have to complete 6 courses Credits in the group: 63

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-MPR	Master Project Zden k Muziká Zden k Muziká (Gar.)	Z	7		Z,L	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-PP.21 Name=Compulsory Courses of Master Study Program, Version 2021

TOTOTOTI LULI					
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 evalu	ate heuristics for practical problems.				
NIE-DIP	Diploma Thesis	Z	30		
NIE-MPR	Master Project	Z	7		
1. At the beginning of the	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 t	he 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 externa		
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 in	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	of the semester.				

and multi-variate integrat	Mathematics for Informatics lected topics from general algebra with emphasis on finite structures used in computer scie ion. The third large topic is computer arithmetics and number representation in a comput their stability analysis. The topics are completed with the demonstration of applications in	er along with error	manipulatio	ti-variate ana on. The last t	topic includes	selected
21st century in computer are becoming a ubiquitou with architectures of para environments for parallel learn the techniques of d practical programming in NIE-VSM Summary of probability th	Parallel and Distributed Programming architectures is primarily influenced by the shift of the Moore's law into parallelization of is commodity and parallel programming becomes the basic paradigm of development of illel and distributed computing systems, their models, theory of interconnection networks programming of shared and distributed memory computers. They get acquianted with fur esign of efficient and scalable parallel algorithms and methods of performance evaluation OpenMP and MPI for solving a particular nontrivial problem. Selected statistical Methods eory; Multivariate normal distribution; Entropy and its application to coding; Statistical tests ains and limiting properties; Queuing theory	efficient application and collective con ndamental parallel n of their implemer	ns for these nmunication algorithms ntations. The	g cores. Par platforms. S operations, and on sele course incl	Students get ac and language cted problems udes a semest	cquainted s and , they will ter project of 7
	ock: Elective vocational courses in the branch/specia r of credits of the block: 0 block: VO	alization				
Name of the gr	oup: NIE-PS-ALL.24 oup: Profiling courses of all masters specializations edits in the group:	of the Infor	matics	progra	ım togetl	ner
•	ourses in the group:					
Credits in the g	5 1					
Note on the gro		pulsory for th	ne specia	alization	in which y	ou intend
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	VO
NIE-KRY	Advanced Cryptology Ji í Bu ek, Róbert Lórencz Ji í Bu ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	VO
NIE-PDB	Advanced Database Systems Martin Svoboda Martin Svoboda (Gar.)	Z,ZK	5	2P+1C	Z	VO
	Advanced Information Systems	Z,ZK	5	2P+1C	L	VO
NIE-PIS	Petr Kroha Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.)	2,21	-	21.10	1 1	
NIE-PIS NIE-AIB	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security	Z,ZK	5	2P+1C	Z	VO
	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns				Z Z	VO VO
NIE-AIB	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	-
NIE-AIB NIE-ADP	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining	Z,ZK Z,ZK	5	2P+1C 2P+1C	Z	VO
NIE-AIB NIE-ADP DA-DMI	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification	Z,ZK Z,ZK Z,ZK	5 5 6	2P+1C 2P+1C 30KP+30KC	Z Z,L	VO VO
NIE-AIB NIE-ADP DA-DMI NIE-SIM	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital innovation	Z,ZK Z,ZK Z,ZK Z,ZK	5 5 6 5	2P+1C 2P+1C 30KP+30KC	Z Z,L L	VO VO VO
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital innovation Michal Valenta Digital strategy and governance	Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK	5 5 6 5 6	2P+1C 2P+1C 30KP+30KC 2P+1C	Z Z,L L Z	VO VO VO VO
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN DD-DSG	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital strategy and governance Michal Valenta Digital strategy and governance Michal Valenta Digital Systems and Computing	Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,K ZK ZK	5 5 6 5 6 6	2P+1C 2P+1C 30KP+30KC 2P+1C 2P+2C	Z Z,L L Z Z	VO VO VO VO VO
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN DD-DSG NIE-DSV	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital strategy and governance Michal Valenta Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.) Effective C++ programming	Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,K ZK ZK Z,K	5 5 6 5 6 6 5 5	2P+1C 2P+1C 30KP+30KC 2P+1C 2P+2C 2P+2C 2P+1C	Z Z,L L Z Z Z	V0
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN DD-DSG NIE-DSV NIE-EPC	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital strategy and governance Michal Valenta Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.) Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.) Embedded Hardware	Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,K ZK Z,K Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK	5 5 6 5 6 6 5 5 5	2P+1C 2P+1C 30KP+30KC 2P+1C 2P+2C 2P+2C 2P+1C 2P+1C	Z Z,L L Z Z Z Z	V0
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN DD-DSG NIE-DSV NIE-EPC NIE-EHW	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital strategy and governance Michal Valenta Digital strategy and governance Michal Valenta Digital strategy and governance Michal Valenta Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.) Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.) Embedded Hardware Jan Schmidt Jan Schmidt (Gar.) Embedded Security	Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK ZK Z,K Z,ZK	5 5 6 5 6 6 5 5 5 5	2P+1C 2P+1C 30KP+30KC 2P+1C 2P+2C 2P+2C 2P+1C 2P+1C 2P+1C	Z Z,L L Z Z Z Z Z Z	V0
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN DD-DSG NIE-DSV NIE-EPC NIE-EHW NIE-EHW	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital strategy and governance Michal Valenta Digital strategy and governance Michal Valenta Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.) Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.) Embedded Hardware Jan Schmidt Jan Schmidt Jan Schmidt (Gar.) Embedded Security Ji f Bu ek, Martin Novotný Martin Novotný Martin Novotný (Gar.) Embedded Software	Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK ZK Z,XK Z,ZK	5 5 6 5 6 5 5 5 5 5	2P+1C 2P+1C 30KP+30KC 2P+1C 2P+2C 2P+1C 2P+1C 2P+1C 2P+2C	Z Z,L L Z Z Z Z Z L	V0
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN DD-DSG NIE-DSV NIE-EPC NIE-EHW NIE-BVS NIE-ESW	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital innovation Michal Valenta Digital strategy and governance Michal Valenta Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.) Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.) Embedded Hardware Jan Schmidt Jan Schmidt Jan Schmidt (Gar.) Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.) Error Control Codes	Z,ZK Z,ZK Z,ZK Z,ZK ZK ZK Z,ZK	5 5 6 5 6 5 5 5 5 5 5 5	2P+1C 2P+1C 30KP+30KC 2P+1C 2P+2C 2P+1C 2P+1C 2P+1C 2P+2C 2P+2C 2P+2C 2P+1C	Z Z,L L Z Z Z Z Z L Z	V0
NIE-AIB NIE-ADP DA-DMI NIE-SIM DD-DIN DD-DSG NIE-DSV NIE-EPC NIE-EHW NIE-EHW NIE-EKO	Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.) Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.) Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.) Data Mining Michal Valenta Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.) Digital innovation Michal Valenta Digital strategy and governance Michal Valenta Digital strategy and governance Michal Valenta Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.) Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.) Embedded Hardware Jan Schmidt Jan Schmidt Jan Schmidt (Gar.) Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.) Error Control Codes Pavel Kubalík Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK Z,ZK Z,ZK Z,ZK ZK ZK Z,ZK Z,ZK	5 5 6 5 6 6 5 5 5 5 5 5 5 5	2P+1C 2P+1C 30KP+30KC 2P+1C 2P+2C 2P+1C 2P+1C 2P+1C 2P+2C 2P+1C 2P+1C 2P+1C	Z Z,L L Z Z Z Z Z L Z L	V0 V0

NIE-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz, Olha Jure ková Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	VO
NIE-AM1	Middleware Architectures 1 Tomáš Vitvar, Milan Doj inovski, Jaroslav Kucha Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-SIB	Network Security Tomáš Zahradnický, Ji í Dostál, Simona Forn sek, Gramoz Cubreli Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-NSS	Normalized Software Systems Jan Verelst, Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	VO
NIE-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	VO
DD-SMN	Strategic management Michal Valenta	ZK	6	4P+0C	Z	VO
NIE-SBF	System Security and Forensics Tomáš Zahradnický, Ji í Bu ek, Simona Forn sek, Marián Svetlík Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-TES	Systems Theory Tomáš Kolárik, Stefan Ratschan, Ji í Vysko il Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	z	VO
NIE-TSP	Testing and Reliability Petr Fišer Petr Fišer Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	VO
NIE-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	VO

Characteristics of the courses of this group of Study Plan: Code=NIE-PS-ALL.24 Name=Profiling courses of all masters specializations of the Informatics program together

DA-DRS Digital Risk And Security (DA-DRS)	Z,ZK	6			
Information technology has become crucial in the growth, sustainability and support of enterprises. However, the pervasive use of technologies also i	ncurs many busine	ess risks, anging			
from abuse, cybercrime, fraud, errors and ommissions. The objective of this course is to understand and analyse IT related business risks and and I	now these risks ca	n be translated			
into an appropiate information risk management and security strategy and action plan. In the course, will first discuss the basics of IT Risk, Information	n Security, and som	ne of the general			
and specific standards and frameworks to address them. Next, we will elaborate on the IT risk management and IT security functions in an organisat	tion. Specific attent	ion will be given			
to risk assessment methods, both qualitative and quantitative. The theoretical knowledge will be applied in a group project, where students will cond	luct a risk assessm	nent in a real			
organisation, and present the results to the responsible managers. Guarantor and teacher: MSc. Steven De Haes, Ph.D.					
NIE-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 know	w the mathematica	al principles of			
random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of					
their own systems or to the creation of their own software solutions.					
NIE-PDB Advanced Database Systems	Z,ZK	5			
Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of data	base machines (sc	called NoSQL			
databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, C	YPHER, Gremlin).	The last part of			
the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PDB.					
NIE-PIS Advanced Information Systems	Z,ZK	5			
Students learn the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the n	otion of service or	iented company,			
enterprise services and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about a	igility and adaptivit	y and using of			
artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of busi	iness processes, b	usiness rules,			
processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS.					
NIE-AIB Algorithms of Information Security	Z,ZK	5			
Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, s	tudents will learn th	ne mathematical			
principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware dete	ection and the use	of machine			
learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems.					
NIE-ADP Architecture and Design patterns	Z,ZK	5			
The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysi	s as well as with u	nderstanding of			
the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge	ge of object-oriente	ed programming			
and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problem	ms. In the second p	part the students			
will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systemeters and analysis.	ems, and some ad [،]	vanced software			
architectures used in large-scale distributed systems.					
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 present, though	often concealed			
in the vastness of the data. With data mining techniques patterns are automatically revealed from such large datasets. First, data mining techniques	and applications a	are discussed.			
Next, we will go into popular predictive and descriptive data mining techniques, with applications in marketing and risk management. Also, analyses	such as social net	twork analysis,			
text mining, process mining, and Big Data will be looked at. Basic programming skills in Python will be learnt. The learned concepts, techniques and	programming lang	guage 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-programme/					
NIE-SIM Digital Circuit Simulation and Verification	Z,ZK	5			
Aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level	Modeling) levels a	nd with the			
properties of proper tools. The course covers today recent verification methods, too.					

DD-DIN	Digital innovation	ZK	6
	innovation in the context of the digital, software-intensive economy. Starting from a broader perspective on innovation, both i		ies and thinking
on innovation, as well a	as alternative views from challengers, are discussed. This includes omnipresent innovation models in which IT-related innovat	ions are adopted	by startups and
scaleups (eg. blockcha	ins or drones) and making them available in certain business domains, which requires agility and speed of development at th	e software level. A	Also, disruptive
innovation, where exist	ing value chains are challenged, is discussed with its requirement for new levels of productivity in software development. Lea	ding theories are	discussed and
illustrated with local an	d international cases using guest lectures. Students of a master double degree specialisation Digital Business Engineering w	ill attend this cour	se during their
stay at the partner univ	ersity Antwerp.		
DD-DSG	Digital strategy and governance	ZK	6
The course provides a	complete and comprehensive overview of what digital governance entails and how it can be applied in practice. The course is	s organized aroun	d the following
three main themes: cor	ncepts and practices of digital governance, the impact of digital governance on business/IT strategic and operational alignment	nt, and the notion	of digital value
and risk. The course is	based on the teacher's knowledge obtained in applied research projects on the relationship between digital governance prac	tices and digital v	alue. To support
	nding and absorbing the material provided, the course uses short assignments and case studies. Students of a master doubl	e degree specialis	sation Digital
	will attend this course during their stay at the partner university Antwerp		
NIE-DSV	Distributed Systems and Computing	Z,ZK	5
Students are introduced	to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of compu	ting processes and	d communication
	asic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms th	hat support high av	vailability of both
	safety in case of failures.		
NIE-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. The course f	ocuses on program	mming effectivity
and efficiency in the for	m of writing maintainable and portable source code and creating correct programs with low memory and processor time requ	uirements.	
NIE-EHW	Embedded Hardware	Z,ZK	5
The course brings basi	c laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the	he base of advand	ced embedded
systems, that profit from	n their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discuss	ed, including stan	dardized means
of internal communicat	ion, parallelism extraction and utilization in special structures and system architectures.		
NIE-BVS	Embedded Security	Z,ZK	5
Students gain basic know	wledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cr	yptographic primit	tives in hardware
and software (in embed	lded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resou	rces for securing i	nternal functions
of computer systems.			
NIE-ESW	Embedded Software	Z,ZK	5
Embedded software co	urse acquainted students with the specifics of software development for embedded systems. The course covers the areas from th	e basic techniques	s of programming
in C language and code	e optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing,	, up to sophisticate	ed techniques
combined with artificial	intelligence.		
NIE-BKO	Error Control Codes	Z,ZK	5
The course expands th	e basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary mal	hematical theory	and principles of
linear, cyclic codes and	I codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to impl	ement these deter	ctions and
corrections for different	types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunication channe	ls.	
NIE-FME	Formal Methods and Specifications	Z,ZK	5
Students are able to de	scribe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some	e software tools th	at allow to prove
basic properties of soft	ware.		
NIE-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain know	ledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the	CUDA programm	ing environment,
which is already a wide	spread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical	computational stru	uctures, students
will also learn optimiza	tion programming techniques and methods of programming multiprocessor GPU systems.		
NIE-HWB	Hardware Security	Z,ZK	5
The course provides th	e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegu	ards against abus	e of the system
using hardware means	. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stu	dents will gain kno	owledge about
the cryptographic acce	lerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the co	omputer.	
NIE-MKY	Mathematics for Cryptology	Z,ZK	5
Students will gain deep	er knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.	In particular, the	course focuses
on the problem of solvi	ng a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discr	ete logarithm. The	e problem of
factorization will also be	e solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
NIE-AM1	Middleware Architectures 1	Z,ZK	5
Students will study new	v trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syst	stem architecture,	web service
architecture and aplicat	ion servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	d high availability
of applications. This co	urse replaces the course MIE-MDW.		
NIE-MTI	Modern Internet Technologies	Z,ZK	5
Students learn advance	ed networking technologies and protocols for both local area networks and wide area networks. They get acquainted with rou	ting techniques ar	nd transfer
technologies of modern	n internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security.		
NIE-MCC	Multicore CPU Computing	Z,ZK	5
	inted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations or	nulticore proces	1
and virtually shared me	emory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of a	rchitecturally spec	cific optimization
techniques used to red	uce the decrease in computing power due to the widening performance gap between the computational requirements of multi	-core CPUs and n	nemory interface
throughput. On specific	non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.		
NIE-SIB	Network Security	Z,ZK	5
	heoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a		1
-	pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network to		
explanation and practic	al examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general	principals of hand	lling detected
security events (i e inc	ident handling and incident response).		

	ormalized Software Systems	haaad on oonoon	to from one		ZK	5
	dations of normalized systems theory that studies the evolvability of modular structures ermodynamics. Students will understand a set of principles that indicate where violatior	-	-	-	-	-
	part of the course, students learn how to construct software architectures using a set of		.,			
=	systems in terms of storing data, executing actions, workflows, connectors, and triggers, w	vhile handling viola	ations of the	stability and	l entropy-relat	ed principles.
	lents to realize new levels of evolvability in software architectures.				Z.ZK	5
	everse Engineering entals of reverse engineering of computer software (methods of executing and initializin	a programs, orga	nization of e	1	,	-
	will be paid to C ++. Students will also become familiar with the principles of debugging					
will focus on code compression and decompression and executable file reconstruction.						
	rategic management			1	ZK	6
	In the first part of the course, the different concepts and perspectives of strategic management are analyzed. The basic characteristics of strategic thinking are being analyzed. Then the importance of mission/vision, as the starting point in strategic thinking, is being discussed. This is being linked to the broader concept of sustainability / corporate social responsibility.					
· ·	on the three basic dimensions of strategy: (1) the strategy content: business level strategy		•		•	
process: strategic formation	n, strategic change, and strategic innovation, (3) the strategy context: the industry conte	ext, the organization	onal context,	and the int	ernational cor	ntext. In each
	e fundamental strategic management paradoxes are situated and evaluated in the strat	• •			•	•
their stay at the partner univ	an be used to manage the strategy process. Students of a master double degree specia versity. Antwerp	ansation Digital Bt	Isiness Eng	ineering will	allend this co	burse during
	ystem Security and Forensics			Z	Z,ZK	5
	to various aspects of system security (principles of endpoint security, principles of secu	rity policies, secu	rity models,			Students will
	nalysis as a tool for investigating security incidents (techniques used by malicious softw	are or attackers, f	orensic ana	lysis technic	ques, and the	importance
	tifacts for attack analysis and detection). ystems Theory				Z,ZK	5
1	ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplar	nes, nuclear powe	r plants). Ho	1	· ·	-
-	the correct behavior of a given system have become critical. A key technique for maste	-				
	t are important for the task at hand, and automated tools for analyzing those models. The	nis subject will pre	sent theory	and algorith	ims that form	the basis for
the modeling and analysis of NIE-TSP					.ZK	5
	esting and Reliability ge about circuit testing and about methods for increasing reliability and security. They w	ill get practical ski	lls to be abl		, 1	-
	on and to use an ATPG for automatic test generation. They will be able to design easily					-
	alyze, and control the reliability and availability of the designed circuits.					
	ser Interface Design				Z,ZK	5
	e theorical background of human-computer interaction and user interface (UI) design, wil ey get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained kn		-			
	rtualization and Cloud Computing				Z,ZK	5
	ge of architectures of large computer systems that are used in data centers and compu	ter infrastructure o	of companie			
1 ·	on principles, tools and technologies that serve to facilitate and automate configuration,	0			•	•
	modern computer systems. Theoretically and practically, they will get acquainted with mputer systems and with specific technologies of cloud systems. Finally, they will learn t					
	ntinuous integration and development).		gampraotio			minogration
Name of the bloc	ck: Elective courses					
Minimal number	of credits of the block: 0					
The role of the b	lock: V					
Code of the grou	In: NIE-V 21					
•	up: Purely elective master's courses					
•						
•	dits in the group:					
•	urses in the group:					
Credits in the gro	pup: 0					
Note on the grou	ip:					
	Name of the course / Name of the group of courses					
Code	(in case of groups of courses the list of codes of their members)	Completion	Credits	Scope	Semester	Role
	Tutors, authors and guarantors (gar.)					
	Blockchain				_	
NIE-BLO	Josef Gattermayer, Róbert Lórencz, Jakub R ži ka, Marek Bielik Josef	Z,ZK	5	1P+2C	Z	V
	Gattermayer Róbert Lórencz (Gar.) Complexity Theory Complexity Theory				_	
NIE-CPX	Dušan Knop, Ond ej Suchý Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	3P+1C	Z	V
NIE-VYC	Computability	Z,ZK	4	2P+2C	L	v
	Jan Starý Jan Štarý Jan Starý (Gar.)	· · ·	· ·			
NIE-MVI	Computational Intelligence Methods Miroslav epek, Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V

Computer arithmetic Pavel Kubalík Pavel Kubalík (Gar.)

Computer Engineering Seminar Master I Hana Kubátová Hana Kubátová Hana Kubátová (Gar.)

Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová (Gar.)

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NIE-ARI

NIE-SCE1

NIE-SCE2

NI-DSW Design Sprint Ond ej Brém, Michal Manda M	l ichal Manda David Pešek (Gar.)	Z	2	30B	Z	V
NI-DID Digital drawing Denisa Nová ková, Eliška Novo (Gar.)	otná Denisa Nová ková Denisa Nová ková	Z	2	4C	Z,L	V
NIE-EVY Efficient Text Pattern Ma Jan Holub Jan Holub Jan H		Z,ZK	5	2P+1C	Z	V
NI-GLR Games and reinforceme Juan Pablo Maldonado Lop		Z,ZK	4	2P+2C	L	v
NI-GRI Grid Computing André Sopczak, Petr Fiedler P	avel Tvrdík André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-HMI History of Mathematics a Alena Šolcová Alena Šolcová		Z,ZK	3	2P+1C	Z	V
NIE-DVG Introduction to Discrete Maria Saumell Mendiola Maria (Gar.)	and Computational Geometry Saumell Mendiola Maria Saumell Mendiola	Z,ZK	5	2P+1C	L	V
FITE-EHD Introduction to European Tomáš Evan	n Economic History	Z,ZK	3	2P+1C	L	V
MIE-MZI Mathematics for data sc Št pán Starosta	ience	Z,ZK	4	2P+1C	L	V
NIE-AM2 Middleware Architecture Milan Doj inovski Milan Doj i	s 2 novski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	v
NIE-OSY Operating Systems and Petr Zemánek Petr Zemánek		Z,ZK	5	2P+1C	Z	V
NIE-PAM Parameterized Algorithn Ond ej Suchý Ond ej Suchý		Z,ZK	4	2P+1C	L	V
NIE-SYP Parsing and Compilers Jan Janoušek Jan Janoušek		Z,ZK	5	2P+1C	Z	V
NIE-ROZ Pattern Recognition Michal Haindl Michal Haindl	Michal Haindl (Gar.)	Z,ZK	5	2P+1C	Z	v
NIE-PML Personalized Machine Lo Rodrigo Augusto Da Silva Alves Alves (Gar.)	earning Karel Klouda Rodrigo Augusto Da Silva	Z,ZK	5	2P+1C	Z	V
NI-AML Advanced machine learn Zden k Buk, Miroslav epek, I Vojt ch Rybá Miroslav epe	Petr Šimánek, Rodrigo Augusto Da Silva Alves,	Z,ZK	5	2P + 1C	L	V
NIE-PDL Practical Deep Learning Martin Barus, Yauhen Babakhiri	Karel Klouda Karel Klouda (Gar.)	KZ	5	2P+1C	Z	V
NIE-VPR Research Project Št pán Starosta Št pán Staro	osta Št pán Starosta(Gar.)	Z	5		Z,L	V
NIE-SWE Semantic Web and Know Milan Doj inovski Milan Doj i	vledge Graphs novski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
MI-SCE1 Computer Engineering S Hana Kubátová	Seminar Master I	Z	4	2C	L,Z	V
NIE-HSC Side-Channel Analysis i Vojt ch Miškovský, Petr Socha	n Hardware Vojt ch Miškovský Vojt ch Miškovský (Gar.)	Z,ZK	4	2P+2C	Z	V
Web Data Mining	novski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIF-BPS Wireless Computer Netv		Z,ZK	4	2P+1C	L	v
NIE-SEP World Economy and Bus Tomáš Evan	siness	Z,ZK	4	2P+1C	Z	V
	siness		1	2P+2C	Z	v

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 pla	, tforms. They will b	e able to design,		
code and deploy a secu	code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places an increased emphasis on the				
relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the students for implementing or					
supervising implementation of blockchain-based solutions in both academia and business.					
NIE-CPX	Complexity Theory	Z,ZK	5		
Students will learn about	t the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	he theory concerr	ning practical		
(in)tractability of difficult	problems.				
NIE-VYC	Computability	Z,ZK	4		
Classical theory of recu	rsive functions and effective computability.				
NIE-MVI	Computational Intelligence Methods	Z,ZK	5		
Students will understan	d the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are pa	arallel in nature ar	nd are applicable		
to solving a wide range of problems. The subject is also devoted to modern neural networks and the ways in which they learn and neuroevolution. Students will learn how these methods					
work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation, etc.					
NIE-ARI	Computer arithmetic	Z,ZK	4		
Students will learn vario	tudents will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units.				

NIE-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 resistan	ce to failures and a	attacks. Students
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	the subject is wor	k with scientific
articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	chers. The topics a	are new for each
semester.		
NIE-SCE2 Computer Engineering Seminar Master II	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 resistan		
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of		
articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	chers. The topics a	are new for each
		0
NI-DSW Design Sprint	Z	2
Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to va		
the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting v testing the prototypes (plus final presentation).	nin research and	nnisning with
NI-DID Digital drawing	Z	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, p		-
they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The cou	-	-
practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice ga	-	
NIE-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 efficient in both ac	1 ' 1	-
They will be able to use the knowledge in design of applications that utilize pattern matching.		mory complexity.
NI-GLR Games and reinforcement learning	Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intellig		
give you both theoretical and practical background so you can participate in related research activities. Presented in English.	jence. mis course	
NI-GRI Grid Computing	Z,ZK	5
Grid computing and gain knowledge about the world-wide network and computing infrastructure.	Ζ,ΖΝ	5
NIE-HMI History of Mathematics and Informatics	Z,ZK	3
The course focuses on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer	1 '	-
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	
	Z,ZK	3
FITE-EHD Introduction to European Economic History The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global of	1 '	-
of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic		-
area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial ins		-
does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions an		
meetings will consist of a mixture of lecture and discussion.	0	,
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		he studied topics
include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality print		-
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		ind technologies
for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.	•	Ū.
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, pi		g context, virtual
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	phasis 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	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often nece		ese problems
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often	one can find a cor	mmon property
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exp	onentially in this (s	small) parameter
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial	al time preprocess	ing of the input,
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 is	presumably) does	s not exist. We
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 various variants	and applications
of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.		
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		-
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, a		-
NIE-PML Personalized Machine Learning	Z,ZK	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	eoretical, algorithm	nic, and practical
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.		r
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 o		
processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the	methods discusse	ed.

	1/7	
NIE-PDL Practical Deep Learning	KZ	5
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine		•
the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields su	ch as computer vi	ision and natural
language processing.		
NIE-VPR Research Project	Z	5
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	tasks that should	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	end of the semes	ter. 2. External
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	AP, 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 th	e assessment to f	the IS based on
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	ad of the departm	nent responsible
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	the upcoming se	emester should
aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.		
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 to	echnologies, meth	hods and best
practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledg	e graphs and the	ir systematic
quality assurance.		
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 resistant	e to failures and a	attacks. Students
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	he subject is wor	k with scientific
articles and other professional 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	are new for each
semester.		
NIE-HSC Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical atta		familiar with
various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks ar		
attacks. They also get practice 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 latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain		
techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an ove		
in the field of social web and recommendation systems.		
NIE-BPS Wireless Computer Networks	Z.ZK	4
Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in a	_,	multicast and
broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get know		
for wireless networks and 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 students of technical university to the international business. It does that predominantly by comparing individual countries and	,	•
Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedomic		
development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on ir		
take bachelor level of this course BIE-SEP as a prerequisite.	go	
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	,	-
Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedon		
development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on in		
take bachelor level of this course BIE-SEP as a prerequisite.	annoual reaulitys	
take bachelor level of this course bit-out as a prefequisite.		

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 present, though often concea				
in the vastness of the data. With data mining techniques patterns are automatically revealed from such large datasets. First, data mining techniques and applications are discussed.				
Next, we will go in	to popular predictive and descriptive data mining techniques, with applications in marketing and risk management. Also, analyses suc	ch as social networ	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	ramme/		
DA-DRS	Digital Risk And Security (DA-DRS)	Z,ZK	6	
Information techno	ogy has become crucial in the growth, sustainability and support of enterprises. However, the pervasive use of technologies also incur	s many business r	isks, anging	
	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 Se		•	
	rds and frameworks to address them. Next, we will elaborate on the IT risk management and IT security functions in an organisation.	•		
to risk assessme	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.			
DD-DIN	Digital innovation	ZK	6	
This course focuse	is on innovation in the context of the digital, software-intensive economy. Starting from a broader perspective on innovation, both main	nstream theories a	and thinking	
on innovation, as well as alternative views from challengers, are discussed. This includes omnipresent innovation models in which IT-related innovations are adopted by startups and				
	kchains or drones) and making them available in certain business domains, which requires agility and speed of development at the s			
innovation, where	existing value chains are challenged, is discussed with its requirement for new levels of productivity in software development. Leadin	g theories are disc	ussed 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.		
DD-DSG	Digital strategy and governance	ZK	6
-	s 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,	-	-
	is based on the teacher's knowledge obtained in applied research projects on the relationship between digital governance practice		•
	erstanding and absorbing the material provided, the course uses short assignments and case studies. Students of a master double	-	
	Business Engineering will attend this course during their stay at the partner university Antwerp		
DD-SMN	Strategic management	ZK	6
-	e course, the different concepts and perspectives of strategic management are analyzed. The basic characteristics of strategic think ssion/vision, as the starting point in strategic thinking, is being discussed. This is being linked to the broader concept of sustainability /		-
	focus on the three basic dimensions of strategy: (1) the strategy content: business level strategy, corporate level strategy, and network	•	
	rmation, strategic change, and strategic innovation, (3) the strategy context: the industry context, the organizational context, and the		
	oters, the fundamental strategic management paradoxes are situated and evaluated in the strategic management theory. Attention is	-	-
management tools v	which can be used to manage the strategy process. Students of a master double degree specialisation Digital Business Engineering	will attend this co	urse during
FITE-EHD	their stay at the partner university Antwerp Introduction to European Economic History	Z,ZK	3
1	es a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global eco	· · ·	1
	n history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic		-
	ire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial instituti		
does not cover deta	ailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and c	organizations in his	tory. Class
FITE-SEP	meetings will consist of a mixture of lecture and discussion.	7 71/	4
	World Economy and Business ces students of technical university to the international business. It does that predominantly by comparing individual countries and k	Z,ZK	
	now about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedon		-
development, which	are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on indiv	idual readings. It is	s advised to
	take bachelor level of this course BIE-SEP as a prerequisite.		
MI-SCE1	Computer Engineering Seminar Master I	Z	4
	puter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to ividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the		
	ofessional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher		
	semester.		
MIE-MZI	Mathematics for data science	Z,ZK	4
	udents are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used in da		
include mainly: line	ear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality princ selected notions from probability theory and statistics.	iple, gradient metr	lods) and
NI-AMI	Advanced machine learning	7 7K	5
NI-AML The course introduce	Advanced machine learning as students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of rec	Z,ZK commendation syst	5 tems, image
The course introduce	5	commendation syst	tems, image
The course introduce processing, co NI-DID	es students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of reconstruction of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the Digital drawing	commendation syst he methods discus Z	tems, image ssed.
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	Error Control Codes	Z,ZK	5			
	is the basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary mathen	, ,				
linear, cyclic codes and codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to implement these detections and						
corrections for different types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunication channels.						
NIE-BLO	Blockchain	Z,ZK	5			
	stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platforn secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places a	-	-			
	secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places a secure 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.		incluing of			
NIE-BPS	Wireless Computer Networks	Z,ZK	4			
	n about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad		-			
	nisms, 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	ole tools.				
NIE-BVS	Embedded Security	Z,ZK	5			
Students gain basic	c knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of crypto	ographic primitives	in hardware			
and software (in en	nbedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources	s for securing intern	al functions			
	of computer systems.					
NIE-CPX	Complexity Theory	Z,ZK	5			
Students will lear	rn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	e theory concerning	g practical			
	(in)tractability of difficult problems.	774	F			
NIE-DDW	Web Data Mining arn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain	Z,ZK	5 h mining			
	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overvie		-			
	in the field of social web and recommendation systems.	w of most recont de	velopmento			
NIE-DIP	Diploma Thesis	Z	30			
NIE-DSV	Distributed Systems and Computing	Z,ZK	5			
	uced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing		-			
	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.		,			
NIE-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5			
	to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with		ntal notions			
	of this discipline, and to be able to solve simple algorithmic problems with a geometric component.					
NIE-EHW	Embedded Hardware	Z,ZK	5			
The course brings	basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the	base of advanced	embedded			
systems, that profit	t from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed,	including standard	ized means			
	of internal communication, parallelism extraction and utilization in special structures and system architectures.					
NIE-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. The course focus	ses on programmir	-			
Students learn how and eff	v to use the modern features of contemporary versions of the C++ programming language for software development. The course focus ficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor t	ses on programmir ime requirements.	ng effectivity			
Students learn how and eff NIE-ESW	to use the modern features of contemporary versions of the C++ programming language for software development. The course focus ficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor t Embedded Software	ses on programmir ime requirements. Z,ZK	ng effectivity 5			
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	Z,ZK	5				
		sors with shared				
techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requiremen	and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization					
techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of multi-core CPUs and memory interface						
throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.						
NIE-MKY Mathematics for Cryptology	Z,ZK	5				
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security						
on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem						
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption syste	-					
NIE-MPI Mathematics for Informatics	Z,ZK	7				
The course focuses on selected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from	1 '	-				
and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error mar		-				
numerical algorithm and their stability analysis. The topics are completed with the demonstration of applications in computer science. The	•					
argumentation.	course locuses on clear pr	esentation and				
	7	7				
NIE-MPR Master Project	<u>Z</u>	7				
1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide						
during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MP						
supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://www.credit.com/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/action/org/actio		,				
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.						
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.						
NIE-MTI Modern Internet Technologies	Z,ZK	5				
Students learn advanced networking technologies and protocols for both local area networks and wide area networks. They get acquain	nted with routing techniques	and transfer				
technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and	with last-mile security.					
NIE-MVI Computational Intelligence Methods	Z,ZK	5				
Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence	1 '	-				
to solving a wide range of problems. The subject is also devoted to modern neural networks and the ways in which they learn and neuroevolu						
work and how to apply them to problems related to data extraction, management, intelligence in games and op						
	ZK	5				
NIE-NSS Normalized Software Systems	1	-				
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from						
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy		•				
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called						
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of	of the stability and entropy-re	elated principles.				
This knowledge allows students to realize new levels of evolvability in software architectures.		1				
NIE-NUR User Interface Design	Z,ZK	5				
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description						
notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the studer	nts will be able to design adv	vanced Uls.				
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 the	hreads, processes, switching	g context, virtual				
memory, system calls, interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating	system architecture with en					
kernel architecture. Within the source, they will goin presting experience with the development of a small but fully fund		nphasis on the				
kernel architecture. Within the course, they will gain practical experience with the development of a small but fully function	tional operating system.	phasis on the				
	tional operating system.	nphasis on the				
NIE-PAM Parameterized Algorithms	Z,ZK	4				
	Z,ZK s often necessary to solve th	4 nese problems				
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	Z,ZK s often necessary to solve th ons. Often one can find a co	4 nese problems mmon property				
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perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial commu	etical, algorithmic, a inities.					
NIE-REV Reverse Engineering	Z,ZK	5				
Students will learn fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of executa						
libraries). Special attention will be paid to C ++. Students will also become familiar with the principles of debugging tools, disassemblers and obfuscation methods. Finally, the course will focus on code compression and decompression and executable file reconstruction.						
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 st						
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, a NIE-SBF System Security and Forensics	Z,ZK	aspects.				
Students will be introduced to various aspects of system security (principles of endpoint security, principles of security policies, security models, authent		1				
also learn about forensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis te						
of memory or file system artifacts for attack analysis and detection).	_					
NIE-SCE1 Computer Engineering Seminar Master I 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	Z	4 ks Students				
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the						
articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher	rs. The topics are r	new for each				
semester.	_	1				
NIE-SCE2 Computer Engineering Seminar Master II	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 are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the						
articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teache						
semester.	1	1				
NIE-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 k Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedor		-				
development, which 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.						
NIE-SIB Network Security	Z,ZK	5				
The students will gain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically abore course explains basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network transported and security threats in computer networks.						
explanation and practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general pi						
security events (i.e. incident handling and incident response).						
NIE-SIM Digital Circuit Simulation and Verification	Z,ZK	5				
Aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level N properties of proper tools. The course covers today recent verification methods, too.	lodeling) levels and	d with the				
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 of the Semantic Web.						
practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge quality assurance.	graphs and their s	systematic				
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 va		-				
The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of va of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.		-				
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