PART A: COURSE PROGRAMME

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time
7.	ISCED code	0613 (Software and applications development and analysis)
8.	Connection between the field of study and university development strategy, including the university mission	The studies in Computer Science are entirely in line with the University's mission and the Development Strategy of the University of Silesia in Katowice for 2020-2025. Computer Science offers 3-semester second-cycle studies, whose task is to educate a graduate who is proficient in using IT knowledge on a theoretical and practical basis. It also prepares a graduate to take up a job in the IT industry in various branches, whether in Poland or abroad. Apart from the practical side, the graduate should have in-depth theoretical knowledge to carry out scientific research in the future, contributing to Computer Science development. The programme offered strengthens the relationship between education, applied research, and the socio-economic environment. The wide range of subjects to choose from provided to Computer Science students allows creating an educational path that suits students, their scientific interests, and professional plans. It fulfils the Strategy's assumption which emphasises the optimisation of fields of study and curricula, considering the educational needs of candidates and students, the labour market, and modern education. Particularly noteworthy is the co-participation of employers in creating study programmes for Computer Science, thus contributing to the construction of innovative education. Thanks to these practices, the graduate becomes competitive in the labour market. The studies also refer to the University's mission, particularly to its primary tasks, to shape ethical social attitudes in scientific work and everyday life.
9.	Number of semesters	3
10.	Degree	magister (Master's Degree)
11.	Specializations	n/a
12.	The semester from which the specializations starts	n/a
13.	Percentage share of scientific or artistic disciplines in education (along with the indication of the leading discipline)	• *[leading discipline]* information and communication technology (engineering and technology): 100%
14.	Percentage of the ECTS credits for each of the scientific or artistic disciplines to which the learning outcomes are related to the total number of ECTS credits (along with the indication of the leading discipline)	• *[leading discipline]* information and communication technology (engineering and technology): 100%
15.	Number of ECTS credits required to achieve the qualification equivalent to the level of study	90

16.	Percentage of the ECTS credits for optional modules in relation to the total number of ECTS credits	60%
17.	Total number of ECTS credits that a student must obtain in the modules taught	50
18.	Number of ECTS credits that a student must obtain in modules assigned to disciplines within the humanities or social sciences (not less than 5 ECTS) - in the case of fields of study assigned to disciplines within the fields other than, respectively, humanities or social sciences	6
19.	Graduation requirements for a particular specialization	The conditions for graduation are as follows: - obtaining credits from all the subject modules defined by the curriculum and successful passing the required examinations, - writing and defending the Master's thesis before the examination board, - obtaining the number of ECTS credits as required by the curriculum.
20.	Organization of the process of obtaining a degree	§1 The present Rules and Regulations of studies are a detailed version of §§ 33, 34, 35, 36, 37, 38 of the legally binding Rules and Regulations of studies at the University of Silesia being an annexe to Resolution No. 368 of the Senate of the University of Silesia in Katowice of 30th April 2019. §2 1. The student makes a declaration regarding the supervisor's selection no later than two weeks after the monographic lecture conducted at the beginning of the first semester. 2. The supervisor determines the diploma thesis subject with the student following the conditions defined under §34 (5) of the Rules and Regulations of studies. Simultaneously, they select modules that correspond to the topic chosen (seven modules) within a group of diploma modules according to the curriculum. Module 8, realised in the third semester, can be selected by the student without consulting the supervisor. 3. The RTP form related to the registration of the diploma thesis (Annexe No. 1 to Order No. 16 of the Rector of the University of Silesia in Katowice of 28th January 2015) signed by the supervisor and the student without undue delay is delivered to the Dean's office related to the particular programme. §3 The student prepares and submits the diploma thesis following the Web Service of the Archives of Diploma Theses (apd.us.edu.pl). §4 1. After submitting by the Master's student the diploma thesis approved by the supervisor, the supervisor and the reviewer prepare the review no later than three days before the Master's examination deadline. 2. Reviews include a proposal of the grade related to the thesis. 3. Reviews are available to the Master's student beforehand so they can get acquainted with them. §5 The conditions for graduation are: – getting credits from all the subject modules defined by the curriculum and successfully passing the required examinations, – writing and defending the Master's thesis before the examination board,

		getting the number of ECTS credits as required by the curriculum. Conditions for admission for the defence of the diploma thesis and the diploma examination: 1. Achieving the required learning outcomes, including getting credits and passing examinations from all modules and the required number of ECTS credits provided for in the curriculum throughout the entire course of education for Computer Science. 2. Submission of the student record book with all the required entries and credits to the last semester's successful passing. 3. Submission of an appropriate number of copies of the diploma thesis and the required documents following the current requirements for submitting diploma theses at the Faculty of Science and Technology. 4. Positive grades from two reviews (i.e. from the supervisor and the reviewer). §6 1. The student takes the diploma examination before the examination board appointed by the Dean of the Faculty of Science and Technology. The board comprises a chairperson and two members (supervisor and reviewer of the thesis), at least one who should have a post-doctoral degree. 2. The diploma examination comprises two parts: (a) defending the diploma thesis, (b) answering questions by the Master's student. 3. The thesis defence begins with the multimedia presentation of the Master's student's thesis subject and answering to the questions from the examination board on the topic presented. 4. In the second part of the examination, the Master's student answers three drawn questions. The questions cover the topics from the modules defined by the 2nd-cycle studies curriculum in Computer Science, excluding the modules not covered by the Master's student. 5. At the end of the examination: a. The examination board establishes component grades related to the answers to the particular examination questions. b. The examination board determines the diploma thesis grade and the final grade be placed on the diploma following the regulations defined under § 38 of the Rules and Regulations of studies. 6. The grades are announced to the Master's student immediately after establishing them by the examination board.
21.	Internships (hours and conditions) in the case of practical programmes and in general university programme - if such requires internship	Not applicable.
22.	Total number of ECTS credits that a student must obtain in internships	0
23.	Number of ECTS credits - higher than 50% of the total number of credits - that a student must obtain: • in general university programmes within a module connected with research carried out in the scientific or artistic disciplines to develop his/her knowledge and research skills; • in practical programmes within a module to develop practical skills	84
24.	General description of the programme	Computer Science offers 3-semester second-cycle studies, whose task is to educate a graduate showing particular proficiency in using IT knowledge on a theoretical and practical basis. The graduate is prepared to take up a job in the IT industry in various branches, whether in Poland or abroad. A second-cycle graduate of Computer Science:

		1. Has a thorough knowledge and skills in advanced fields of computer science; 2. Has analytical and synthetic thinking skills, allowing for a non-standard approach to solving various practical problems requiring analysis, creation or adaptation of advanced IT technologies; 3. Can construct information technology solutions based on mathematical models and assess, test, and secure those solutions; 4. Is aware of the importance and impact of IT professional activity and understands the importance of intellectual integrity; 5. Ability to present advanced IT content in speech and writing and to discuss it rationally; 6. Can independently expand and deepen their knowledge of current IT trends; 7. Has high qualifications and practical skills in information technology, making them competitive in the labour market.
25.	General description of the specialization	The programme does not include any majors.

PART B: LEARNING OUTCOMES

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Code of the learning outcome of the programme	**Learning outcomes** The graduate:	Codes of the second-order PRK characteristics to which the learning outcome of the programme is related
	KNOWLEDGE	
K_W01	has an expanded and in-depth knowledge of mathematics to the extent necessary for formulating and solving complex tasks in the field of computer science	2018_P7S_WG
K_W02	is familiar with advanced IT methods, techniques and tools used to solve complex IT problems	2018_P7S_WG
K_W03	has an extended knowledge of the operation, maintenance and management of modern computer systems, including the context of the operation of computer networks	2018_P7S_WG
K_W04	has knowledge of programming, implementation of algorithms, paradigms and programming styles, methods of verifying the correctness of programmes, formal languages and various programming environments	2018_P7S_WG
K_W05	has a structured theoretical knowledge of the design and implementation methods of complex IT systems used in various fields, including teamwork methods	2018_P7S_WG
K_W06	has a well-founded knowledge about protocols and services in computer networks, including specialized communication protocols	2018_P7S_WG
K_W07	has knowledge necessary to understand the social, economic, legal and ethical conditions of engineering activities	2018_P7S_WK
K_W08	has an enhanced knowledge of intellectual property protection and patent law; has a basic knowledge of quality management and business conduct	2018_P7S_WK
K_W09	has an enhanced knowledge of data processing and analysis	2018_P7S_WG
W_OOD	has an in-depth knowledge of the selected scientific methods and is familiar with issues specific for the discipline of science not related to the programme	2018_P7S_WG, 2018_P7S_WK
	SKILLS	
K_U01	can obtain information from literature, databases and other properly selected sources, can integrate the information obtained, interpret it, draw conclusions and formulate and justify opinions	2018_P7S_UW
K_U02	can work individually and collectively, can lead a small team, can develop and implement a work schedule to meet deadlines	2018_P7S_UO
K_U03	can develop detailed documentation on the implementation of a project task and prepare the elaboration of the results of the implementation of this task	2018_P7S_UW
K_U04	can prepare and present an oral presentation on the implementation of the project task and lead a discussion on the presentation	2018_P7S_UK
K_U05	can critically assess existing IT systems and propose their improvement	2018_P7S_UW
K_U06	can define and implement the process of self-education e.g. to improve professional competences	2018_P7S_UU

K_U07	communicates in a foreign language using advanced language communication competences, has the ability to comprehensively read complex scientific texts and has an in-depth ability to prepare various written works (including research ones) and oral presentations on detailed issues in a given programme in a foreign language	2018_P7S_UK
K_U08	can use learned mathematical methods and models, as well as computer simulations to complete project tasks	2018_P7S_UW
K_U09	can use advanced IT methods, techniques and tools to solve complex IT problems and plan and perform experiments in this field	2018_P7S_UW
K_U10	can design an IT system by defining the basic structural and object models of the designed system	2018_P7S_UW
U_OOD	has advanced skills to set scientific questions and analyse problems or to solve problems practically on the basis of the course content, experience and skills gained in a particular field of science unrelated to the leading discipline of the study programme	2018_P7S_UW
SOCIAL COMPETENCES		
K_K01	understands the need and the necessity to continuously learn and improve one's professional and personal competences	2018_P7S_KK
K_K02	understands the importance of non-technical aspects of professional IT activities and the related legal and ethical responsibility	2018_P7S_KO
K_K03	acts ethically, understands the importance of intellectual honesty of themselves and others	2018_P7S_KR
K_K04	acts ethically, understands the importance of honesty in own actions and the actions of others	2018_P7S_KK
K_K05	is aware of the social role of a university graduate and, in particular, understands the need to formulate and communicate to the public information and opinions on the achievements of computer science and other aspects of the activities of an IT engineer e.g. through the media; tries to provide this information in a commonly understood manner	2018_P7S_KO
K_OOD	understands the need for multidisciplinary approach to problem solving, integrating knowledge or using skills from various disciplines, and practicing self-study for deepening the acquired knowledge	2018_P7S_KK

PART C: COURSE STRUCTURE

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time
7.	Academic year for which the revised course structure applies	—

Obligatory courses

				form of teaching				year 1						year 2		
								semester 1			semester 2			semester 3		
No.	**Module**	**Lang.**	**E/C**	**Total**	**L**	**O**	**Total ECTS**	**L**	**O**	**E**	**L**	**O**	**E**	**L**	**O**	**E**
1	Algorithmics and advanced data structures	EN	E	60	30	30	4	30	30	4						
2	Computer simulations	EN	E	60	30	30	4	30	30	4						
3	Modern programming languages	EN	E	60	30	30	4	30	30	4						
4	Statistical analysis in research	EN	Z	30	15	15	2	15	15	2						
5	Computer network technologies	EN	Z	45	15	30	3				15	30	3			
6	Concurrent programming	EN	Z	30	15	15	2				15	15	2			
7	Data mining	EN	E	60	30	30	4				30	30	4			
8	Managing IT projects and teams	EN	Z	30	10	20	2				10	20	2			
9	Monographic lecture - Combinatorial machine learning	EN	Z	30	30		2				30		2			
10	General academic module (Humanities)	EN	Z	45		45	3								45	3
11	General academic module (Social Sciences)	EN	Z	30		30	2								30	2
12	Intellectual property protection	EN	Z	15	15		2							15		2
13	IT for the blind and visually impaired	EN	Z	15	15		2							15		2
14	Mathematical modeling of optimization problems	EN	Z	30	15	15	3							15	15	3
	TOTAL Obligatory courses:			**540**	**250**	**290**	**39**	**105**	**105**	**14**	**100**	**95**	**13**	**45**	**90**	**12**

Diploma courses

				form of teaching				year 1						year 2		
								semester 1			semester 2			semester 3		
No.	**Module**	**Lang.**	**E/C**	**Total**	**L**	**O**	**Total ECTS**	**L**	**O**	**E**	**L**	**O**	**E**	**L**	**O**	**E**
1	Diploma courses group I *[see description below]*	*	*	135	45	90	12	45	90	12						
2	Introduction to scientific research.	EN	Z	2		2	1		2	1						
3	Master's seminar I	EN	Z	15		15	2		15	2						
4	Monographic lecture	EN	Z	20	20		1	20		1						
5	Diploma courses group II *[see description below]*	*	*	135	45	90	12				45	90	12			
6	Master's seminar II	EN	Z	30		30	2					30	2			
7	Master's workshop I	EN	Z	45		45	3					45	3			
8	Diploma courses group III *[see description below]*	*	*	45	15	30	4							15	30	4
9	Master's seminar III - thesis preparation	EN	Z	30		30	9								30	9
10	Master's workshop II	EN	Z	45		45	5								45	5
	TOTAL Diploma courses:			**502**	**125**	**377**	**51**	**65**	**107**	**16**	**45**	**165**	**17**	**15**	**105**	**18**

Diploma courses				form of teaching				year 1						year 2		
								semester 1			semester 2			semester 3		
No.	Module	Lang.	E/C	Total	L	O	Total ECTS	L	O	E	L	O	E	L	O	E
	TOTAL:			1042	375	667	90	382		30	405		30	255		30
TOTAL								1042								

Studia kończą się nadaniem tytułu zawodowego magistra na kierunku Computer Science.

* Groups of modules

Diploma courses group I

Description:					
The student chooses three modules from the list. No module may be repeated during the entire course of education.					
Modules:	Lang.	E/C	L	O	ECTS
Administration of network services	EN	C	15	30	4
Advanced methods of data analysis	EN	C	15	30	4
Algorithmically generated graphics	EN	C	15	30	4
Artificial intelligence in computer graphics	EN	C	15	30	4
Biometric recognition and access control systems	EN	C	15	30	4
Cloud computing technologies	EN	C	15	30	4
Cluster analysis algorithms in applications	EN	C	15	30	4
Computational geometry	EN	C	15	30	4
Computational intelligence techniques	EN	C	15	30	4
Data analysis in business	EN	C	15	30	4
Data visualization	EN	C	15	30	4
Data warehouses	EN	C	15	30	4
Decision and association rules in knowledge data discovery	EN	C	15	30	4
Decision support systems	EN	C	15	30	4
Deep learning with neural networks	EN	C	15	30	4
Fractal methods in computer graphics	EN	C	15	30	4
Fuzzy sets nad systems	EN	C	15	30	4
GPGPU computing	EN	C	15	30	4
Image and video processing techniques	EN	C	15	30	4
Image processing algorithms in biometrics and bioinformatics	EN	C	15	30	4
Intelligent data processing	EN	C	15	30	4
Internet of things technologies	EN	C	15	30	4
Internet protocols	EN	C	15	30	4
Introduction to data classificatin and clusterization in biometry	EN	C	15	30	4
Introduction to reverse engineering	EN	C	15	30	4
Machine learning in biometrics and bioinformatics	EN	C	15	30	4
Methods of group decision making	EN	C	15	30	4
Microcomputers and network couplers	EN	C	15	30	4
Mobile systems and applications	EN	C	15	30	4

Network systems security	EN	C	15	30	4
Object-relational database systems in biometry	EN	C	15	30	4
Outlier detection algorithms	EN	C	15	30	4
Procedural content generation	EN	C	15	30	4
Real-time graphics	EN	C	15	30	4
Recommendation systems and social networks	EN	C	15	30	4
Scripting languages in data analysis	EN	C	15	30	4
Selected graph algorithms	EN	C	15	30	4
Techniques for optimizing computer programs	EN	C	15	30	4
The concept of programming languages	EN	C	15	30	4
Web applications	EN	C	15	30	4
Wireless and sensor networks	EN	C	15	30	4

Diploma courses group II

Description:					
The student chooses three modules from the list. No module may be repeated during the entire course of education.					
Modules:	Lang.	**E/C**	**L**	**O**	**ECTS**
Administration of network services	EN	C	15	30	4
Advanced methods of data analysis	EN	C	15	30	4
Algorithmically generated graphics	EN	C	15	30	4
Artificial intelligence in computer graphics	EN	C	15	30	4
Biometric recognition and access control systems	EN	C	15	30	4
Cloud computing technologies	EN	C	15	30	4
Cluster analysis algorithms in applications	EN	C	15	30	4
Computational geometry	EN	C	15	30	4
Computational intelligence techniques	EN	C	15	30	4
Data analysis in business	EN	C	15	30	4
Data visualization	EN	C	15	30	4
Data warehouses	EN	C	15	30	4
Decision and association rules in knowledge data discovery	EN	C	15	30	4
Decision support systems	EN	C	15	30	4
Deep learning with neural networks	EN	C	15	30	4
Fractal methods in computer graphics	EN	C	15	30	4
Fuzzy sets nad systems	EN	C	15	30	4
GPGPU computing	EN	C	15	30	4
Image and video processing techniques	EN	C	15	30	4
Image processing algorithms in biometrics and bioinformatics	EN	C	15	30	4
Intelligent data processing	EN	C	15	30	4
Internet of things technologies	EN	C	15	30	4
Internet protocols	EN	C	15	30	4
Introduction to data classificatin and clusterization in biometry	EN	C	15	30	4
Introduction to reverse engineering	EN	C	15	30	4
Machine learning in biometrics and bioinformatics	EN	C	15	30	4
Methods of group decision making	EN	C	15	30	4
Microcomputers and network couplers	EN	C	15	30	4

Mobile systems and applications	EN	C	15	30	4
Network systems security	EN	C	15	30	4
Object-relational database systems in biometry	EN	C	15	30	4
Outlier detection algorithms	EN	C	15	30	4
Procedural content generation	EN	C	15	30	4
Real-time graphics	EN	C	15	30	4
Recommendation systems and social networks	EN	C	15	30	4
Scripting languages in data analysis	EN	C	15	30	4
Selected graph algorithms	EN	C	15	30	4
Techniques for optimizing computer programs	EN	C	15	30	4
The concept of programming languages	EN	C	15	30	4
Web applications	EN	C	15	30	4
Wireless and sensor networks	EN	C	15	30	4

Diploma courses group III

Description:					
The student chooses three modules from the list. No module may be repeated during the entire course of education.					
Modules:	Lang.	**E/C**	**L**	**O**	**ECTS**
Administration of network services	EN	C	15	30	4
Advanced methods of data analysis	EN	C	15	30	4
Algorithmically generated graphics	EN	C	15	30	4
Artificial intelligence in computer graphics	EN	C	15	30	4
Biometric recognition and access control systems	EN	C	15	30	4
Cloud computing technologies	EN	C	15	30	4
Cluster analysis algorithms in applications	EN	C	15	30	4
Computational geometry	EN	C	15	30	4
Computational intelligence techniques	EN	C	15	30	4
Data analysis in business	EN	C	15	30	4
Data visualization	EN	C	15	30	4
Data warehouses	EN	C	15	30	4
Decision and association rules in knowledge data discovery	EN	C	15	30	4
Decision support systems	EN	C	15	30	4
Deep learning with neural networks	EN	C	15	30	4
Fractal methods in computer graphics	EN	C	15	30	4
Fuzzy sets nad systems	EN	C	15	30	4
GPGPU computing	EN	C	15	30	4
Image and video processing techniques	EN	C	15	30	4
Image processing algorithms in biometrics and bioinformatics	EN	C	15	30	4
Intelligent data processing	EN	C	15	30	4
Internet of things technologies	EN	C	15	30	4
Internet protocols	EN	C	15	30	4
Introduction to data classificatin and clusterization in biometry	EN	C	15	30	4
Introduction to reverse engineering	EN	C	15	30	4
Machine learning in biometrics and bioinformatics	EN	C	15	30	4
Methods of group decision making	EN	C	15	30	4

Microcomputers and network couplers	EN	C	15	30	4
Mobile systems and applications	EN	C	15	30	4
Network systems security	EN	C	15	30	4
Object-relational database systems in biometry	EN	C	15	30	4
Outlier detection algorithms	EN	C	15	30	4
Procedural content generation	EN	C	15	30	4
Real-time graphics	EN	C	15	30	4
Recommendation systems and social networks	EN	C	15	30	4
Scripting languages in data analysis	EN	C	15	30	4
Selected graph algorithms	EN	C	15	30	4
Techniques for optimizing computer programs	EN	C	15	30	4
The concept of programming languages	EN	C	15	30	4
Web applications	EN	C	15	30	4
Wireless and sensor networks	EN	C	15	30	4

Legend

Each semester consists of 15 weeks
E/C - examination/course work
E - ECTS
L - lecture, O - all forms of teaching excluding lecture (practical classes, laboratory classes, discussion classes, seminar, proseminar, language classes, field practice, workshop, internship, tutoring)

PART D: MODULES DESCRIPTION

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Administration of network services

Module code: W4-INA-S2-20-F-AUS

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has skills in installing and configuring network services.	K_U01 K_W06	1 1
M_002	The student has knowledge about network services and servers.	K_W03 K_W06	1 1
M_003	The student has competences necessary to use the acquired knowledge in administration network services.	K_K01 K_U01 K_U02 K_U03 K_U04 K_W03	1 1 1 1 1 1

3. Module description

Description	The module's aim is to provide students with knowledge covering practical and theoretical aspects of network service management. The issues discussed include server software, methods of configuration, sharing and monitoring network services, and principles of ensuring their security and performance
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Final test	The two-hour test comprises closed and open-ended questions.	M_001, M_002
W_002	Reports	The students presentation their reports and discuss developed projects.	M_001, M_003

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	Lectures are supported by multimedia presentations and e-learning	15	The student is required to self-study the literature and materials presented during lectures	25	W_001
Z_002	laboratory classes	There are assignments as design tasks with the use of server software.	30	The student is required to solve design tasks and prepare presentations	50	W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Advanced methods of data analysis

Module code: W4-INA-S2-20-F-ZMAD

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The module's aim is to present data analysis possibilities with different methods based on the signal theory using spectral analysis. Data analysis aims at extracting useful information from the data and deciding based on data distribution. The gained skills will help the students clean, transform, and model data to find helpful information for business and make scientific decisions	K_K04 K_K05 K_U01 K_U02 K_U03 K_U05 K_U09 K_W01 K_W09	1 1 1 1 1 1 1 1 1

3. Module description

Description	The lectures discuss the identification of phenomena occurring in data sets. These phenomena, such as the properties of the Boolean function, data compression or steganography, will be detected using selected discrete transforms, such as Fourier, Cosinus, Sinus, and Walsh or Haar.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The aim of the test is to verify learning progress and suggestions for necessary repetitions of the material along with participation in consultations.	M_001
W_002	Development of a computer	The student presents and discusses the implementation details of the programme, with the	M_001

	programme	help of which they solve the problem of analysing data given in the form of a set of numbers.	

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	Classes are conducted in the form of lectures supported with multimedia. The theoretical basis will be discussed on the basis of practical applications. Some lectures will also include discussions with students about alternative solution options.	15	The student should read the relevant literature materials for each lecture. To better understand the problem, the student should also solve the exercises given in the lectures and consult them with the lecturer.	45	W_001
Z_002	laboratory classes	Matlab will be introduced as a programming method in the laboratory. The student develops computer programmes that can be used to complete tasks discussed in the lectures or tasks indicated by the laboratory teacher. Programming issues will be discussed during laboratory meetings	30	During individual work, the student should check different versions of the programme code, paying attention to programme optimisation. Different discrete transforms can be programmed in alternative ways, generating different approximations of results. These nuances should be tested in the course of individual work.	30	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Algorithmically generated graphics

Module code: W4-INA-S2-20-F-GGA

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can design algorithms for generating graphics.	K_K03 K_U01 K_U04 K_W01 K_W02	1 2 1 2 3
M_002	The student can implement algorithms for generating graphics.	K_K01 K_U02 K_W02 K_W04	1 1 3 2
M_003	The student knows how to use algorithms for generating graphics.	K_K01 K_U01 K_W02	1 2 3

3. Module description

Description	The content of the subject discusses computational solutions to design problems. "Generative art" has become a term for describing works of art expressed as code. The repertoire of algorithmically generated graphics can be defined as a set of simple rules. The algorithmic creation of the simplest forms is presented and new ways to approach them are considered. The following topics will be presented in this module: elements of calculations, vectors, points, objects, coordinate systems; controls, algorithms, transforms, randomness, artificial intelligence, fractals; design of two- and three-dimensional objects.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Project report	The students submit their projects (applications) within the deadline as verification of skills acquired in solving problems.	M_001, M_002, M_003
W_002	Test	test of theoretical issues	M_003

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	Lectures are carried out by using audiovisual means.	15	Studying lecture topics basing on books and materials from the Internet.	30	W_002
Z_002	laboratory classes	Compulsory classes in the computer lab conducted according to the schedule.	30	Solving practical tasks. Development and practical implementation of the project.	45	W_001

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Algorithmics and advanced data structures

Module code: W4-INA-S2-20-1-AiZSD

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows advanced methods of determining the computational complexity of algorithms; knows and understands classes of algorithms complexity.	K_W01 K_W04	2 2
M_002	The student knows advanced paradigms of algorithms constructing, e.g. exhaustive search or greedy strategies; knows and understands basics of operation and advantages and disadvantages of these algorithms.	K_W04	4
M_003	The student knows graph algorithms	K_W01 K_W04	1 3
M_004	The student understands the concept of approximation algorithm and knows examples of such algorithms using different approaches, e.g. combinatorial or based on the theory of linear programming	K_W01 K_W04	1 3
M_005	The student knows examples of Monte-Carlo and Las-Vegas randomised algorithms.	K_W01 K_W04	1 3
M_006	The student can designate computational complexity of recurrent algorithms and record their complexity, e.g. as a recurrent equation, and solve such an equation.	K_W01 K_W04	2 2
M_007	The student can choose and implement an appropriate, basic or advanced algorithm construction paradigm to solve a problem and justify such a choice.	K_U08 K_U09	1 3
M_008	The student can implement an appropriate algorithm to solve a problem and select a suitable data structure.	K_U09	3
M_009	The student is aware of the significant impact of the algorithms' characteristics such as complexity or correctness, constituting the essential components of larger systems, such as modules, functions or procedures, on the final efficiency, correctness and safety of these systems.	K_K01 K_U09	1 2

3. Module description	
Description	Algorithmics is the science of algorithms. It includes algorithm design, i.e. the art of building a schema that effectively solves a specific problem or class of problems and algorithm analysis. This module introduces the participant to advanced algorithm design methods and issues of algorithms and data structures analysis.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Written exam	The exam is designed to verify the knowledge based on the content presented during lectures	M_001, M_002, M_003, M_004, M_005, M_006, M_009
W_002	Reports	The students complete the assigned tasks and elaborate them in the form of reports.	M_006, M_007, M_008, M_009

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have an audiovisual form with the additional use of some written educational aids.	30	The students are required to self-study for the exam.	30	W_001
Z_002	laboratory classes	The students prepare for solving tasks individually by studying the proceeding method and the sequence of operations.	30	Classes prepare the students for completing the assigned tasks individually during the laboratory class. They are also required to elaborate on reports.	30	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Artificial intelligence in computer graphics

Module code: W4-INA-S2-20-F-SIwGK

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows evolutionary algorithms, neural networks, and machine learning methods and understands optimisation and control issues. The student knows how to define a problem, find a solution, develop a mathematical model, and apply selected artificial intelligence algorithms.	K_K01 K_K03 K_U01 K_U06 K_U08 K_W01 K_W02 K_W05	1 1 1 1 1 1 1 1
M_002	The student knows the rules of modelling 3D scenes, e.g. problems of physical environment simulation, motion planning, object detection, or collision avoidance.	K_K01 K_U02 K_U04 K_W04 K_W05	1 1 1 1 1
M_003	The students can work individually or in a team, understand the importance of intellectual honesty in their and other people's activity. They understand the need to improve their competencies continuously. The student thinks creatively, form opinions on fundamental issues, current state and development trends in IT, and understands non-technical issues of professional activity.	K_K01 K_K02 K_K03 K_U01 K_U02 K_U03 K_U04	1 1 1 1 1 1 1

		K_W03 K_W04 K_W05	1 1 1

3. Module description	
Description	The course aims at acquainting the students with issues related to the use of artificial intelligence methods in computer graphics.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Project	The students implement of a semester project in learning outcomes adopted in the module.	M_001, M_003
W_002	Project presentation	The students present the project in front of the group, discussion of the assumptions and the adopted method of solving a specific problem, analysing and assessing the project goal's implementation.	M_003
W_003	Test	The test comprises open and closed-ended questions	M_001, M_002

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The content of the course is presented in a multimedia form.	15	The students are required to self-study the lecture topics and recommended literature.	30	W_003
Z_002	laboratory classes	The students practice implementing the curriculum elements as assigned tasks on computer stations with dedicated software.	30	1. The students prepare individually for laboratory classes. 2. The students execute the project in a group or individually and prepare its documentation. 3. The students prepare multimedia presentations about the completed project and show them in front of the group.	45	W_001, W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Biometric recognition and access control systems

Module code: W4-INA-S2-20-F-BSRUK

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student should solve problems individually or in a team, using the gained knowledge and practical skills.	K_K01 K_K03 K_K04 K_U01 K_U02	1 1 1 1 1
M_002	The student knows the biometric data acquisition and processing process.	K_W01 K_W02 K_W03 K_W05 K_W09	1 1 1 1 1
M_003	The student knows and understands the operation of selected methods and algorithms for biometric verification or identification.	K_W01 K_W02 K_W04 K_W05 K_W09	1 1 1 1 1
M_004	The student can design hybrid biometric security systems.	K_U01 K_U03 K_U05 K_U09 K_U10	1 1 1 1 1

		K_W01 K_W02 K_W09	1 1 1
M_005	The student knows the construction and operation of access control systems.	K_U01 K_U10 K_W01 K_W02 K_W03 K_W06 K_W09	1 1 1 1 1 1 1
M_006	The student can test and refer to the advancement of his work or teamwork.	K_K01 K_U03 K_U04 K_U05	1 1 1 1

3. Module description	
Description	This course aims at introducing the issues of broadly understood biometrics and biometric access control systems.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The students solve a theoretical test related to the topics discussed in the lectures.	M_002, M_003, M_005
W_002	Project documentation	The students present the full documentation of the project, including all stages of its implementation.	M_001, M_002, M_003, M_004, M_005, M_006

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures primarily focus on the most challenging issues and those deeply rooted in theory. The students are encouraged by asking them questions concerning the presented content.	15	The students prepare for the test individually.	10	W_001
Z_002	laboratory classes	The students work in the laboratory on computers and biometric measuring devices.	30	The students study for the labs. They complete tasks assigned to the labs and	65	W_002

		There are both traditional and e-learning classes.		prepare report presentations and develop biometric identification or verification systems.		

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Cloud computing technologies

Module code: W4-INA-S2-20-F-TCO

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has the skills needed for implementing cloud services.	K_U09 K_W02	1 1
M_002	The student knows cloud computing service models..	K_W03	1
M_003	The student can implement the concepts in real-world applications of cloud computing.	K_U09	1

3. Module description

Description	The module aims at giving the students the knowledge necessary to create scalable and reliable applications in cloud environments. The presented topics are related to the architecture of cloud computing platforms, models of cloud services, virtualisation, data security in the cloud, dedicated programming methods, hardware solutions, and migration of existing applications to cloud computing. Students will gain the abilities to manage cloud services.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Final test	Two-hour test with closed and open-ended questions	M_001, M_002
W_002	Reports	Presentation of the reports and discussion on the developed projects.	M_001, M_003

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures involve multimedia presentations and e-learning.	15	The students are required to self-study the literature and materials presented during the lectures.	25	W_001
Z_002	laboratory classes	The students prepare assignments like design projects with the use of computational cloud services.	30	The students complete project assignments and prepare presentations.	50	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Cluster analysis algorithms in applications

Module code: W4-INA-S2-20-F-AASwP

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student is aware of grouping algorithms' advantages and their impact on learning the analysed data and their fields.	K_K02	1
M_002	The student knows the basics of data mining, including data types, similarity measures, and methods for determining cluster representatives.	K_W01 K_W02 K_W04 K_W09	2 2 2 3
M_003	The student knows partitioning grouping algorithms, including k-means and k-medoids.	K_W04 K_W09	2 3
M_004	The student knows hierarchical grouping algorithms, including AHC.	K_W04 K_W09	2 3
M_005	The student knows density grouping algorithms, including DBSCAN.	K_W02 K_W04 K_W09	2 2 3
M_006	The student can determine the similarity/distance of objects relative to each other in multidimensional space.	K_U01 K_U03 K_U08 K_U09	2 2 2 3
M_007	The student can implement or use ready-made libraries/packages that allow a split algorithm for any actual data set.	K_U01 K_U03 K_U08	1 2 2

		K_U09	3
M_008	The student can implement or use ready-made libraries/packages that allow a hierarchical algorithm for any actual data set.	K_U01 K_U03 K_U08 K_U09	1 2 2 3
M_009	The student can implement or use ready-made libraries/packages that allow a density algorithm for any actual data set.	K_U01 K_U03 K_U08 K_U09	1 2 2 3
M_010	The student can appoint a representative of a group of objects in the multidimensional space.	K_U01 K_U03 K_U08 K_U09	2 3 2 4
M_011	The student can visualise the received structure of groups and interpret it correctly.	K_U01 K_U03 K_U09	1 2 3

3. Module description	
Description	The goal is to introduce the listener to cluster analysis algorithms: division, hierarchical, density or new cluster analysis algorithms. The students will also consider their practical uses in medicine.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	exam (test)	The test checks how the students internalised content presented during the lectures. The exam comprises both open and closed-ended theory questions.	M_001, M_002, M_003, M_004, M_005, M_006, M_007, M_008, M_009, M_010, M_011
W_002	Projects and reports	The students will develop projects with reports within deadlines to verify the skills gained in solving problems.	M_001, M_006, M_007, M_008, M_009, M_010, M_011

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are based on audiovisual aids with the additional use of some written educational ones.	15	Preparation for the exam.	15	W_001
Z_002	laboratory classes	The students prepare for solving tasks individually by studying the proceeding method and the sequence of operations.	30	Classes prepare the students for completing the assigned tasks individually during the laboratory class. They are also required to elaborate on reports.	60	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Computational geometry

Module code: W4-INA-S2-20-F-GO

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows and understands mathematical notions used in computational geometry.	K_W01	1
M_002	The student knows and understands the basic algorithms used in computational geometry.	K_W04	1
M_003	The student can get information about computational geometry from literature, databases and other sources.	K_W01 K_W04	1 1
M_004	The student can prepare and conduct a presentation on the completion of the project task.	K_U01 K_U07	1 1
M_005	The student can work individually and in a team.	K_U03 K_U04	1 1
M_006	The student can think and act creatively.	K_U02	1
M_007	Can think and act creatively.	K_K01 K_K03	1 1

3. Module description

Description	The aim of the classes is to introduce to the students the basics of computational geometry. Some geometric problems that arise, e.g. in robotics, GIS systems, computer games, and ways to solve them efficiently with algorithms and dedicated data structures will be presented. During the course, the students will prepare projects in two-person teams and present their work results in front of the group.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Project	The student prepares the project and presentation on the chosen topic connected with computational geometry.	M_001, M_002, M_003, M_004, M_005, M_006, M_007
W_002	Reports	The student reports on solved sets of assigned tasks.	M_001, M_002, M_003, M_006, M_007

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lecture are presented with the use of audiovisual methods.	15	The students are required to self-study the topics presented during the lectures and assigned literature.	15	W_001
Z_002	laboratory classes	The lectures aim at detailed preparing the students to use of geometry algorithms in practice. The students complete assigned programming tasks.	30	The students study for laboratory classes individually, but prepare projects and present them in teams.	60	W_001, W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Computational intelligence techniques

Module code: W4-INA-S2-20-F-TIO

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows advanced meta-heuristics and their applications in selected optimisation problems.	K_W01 K_W02	1 1
M_002	The student can select a method to solve a presented optimisation problem.	K_U01 K_U05	1 1
M_003	The student can write a program that implements selected meta-heuristics for optimising calculations.	K_U02 K_U03 K_U04	1 1 1
M_004	The student understands the need to develop decision-making methods for optimisation problems.	K_K01	1

3. Module description

Description	The meta-heuristic algorithm can solve any problem that can be described with some terms defined by this algorithm. However, it is most often used to solve optimisation problems. A disadvantage of meta-heuristic algorithms is that they do not guarantee to find a solution, and it is usually impossible to give the time of their operation. The effectiveness of meta-heuristics also depends mostly on the parameters that appear in such algorithms. Unfortunately, there are no universal values of these parameters that behave best for all input data.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The student writes a test and describes existing techniques and their adaptation to selected optimisation problems.	M_001

W_002	Programme related to the implemented project presentation.	The student presents the programme and verifies its effectiveness for the selected optimisation problem.	M_001, M_002, M_003
W_003	Multimedia presentation	The student presents the advantages and disadvantages of the selected computational intelligence technique and tests it on a specific optimisation problem.	M_001, M_002, M_004

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures combine verbal presentations with the use of content visualisation. They are focused on conceptually demanding material and refer to addresses of websites and e-learning package	15	The students acquire knowledge from the lectures using the existing packages of methods: script, websites, and e-learning	30	W_001
Z_002	laboratory classes	Laboratory classes prepare students for implementing algorithms with an emphasis on the method and the sequence of operations.	30	The student self-studies for the test from the laboratory classes. The students implement systems working in groups	45	W_001, W_002, W_003

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Computer network technologies

Module code: W4-INA-S2-20-2-TSK

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can characterise network devices, such as network interface card, switch, router, host, and describe issues connected with switching frames and routing packets.	K_W02 K_W03 K_W06	1 3 1
M_002	The student understands the need to use the layered network model OSI-7 to describe phenomena occurring in computer networks and knows divisions of phenomena occurring on the Internet within the TCP/IP stack.	K_W03 K_W05 K_W06	2 2 2
M_003	The student can establish a local network using various transmission media using point-point and infrastructure topologies and test various media and links.	K_U01 K_U03 K_U05 K_U10	1 1 1 1
M_004	The student can configure a router as a core layer device, construct a network comprising the L3 layer subnets, and design vertical and horizontal cabling.	K_U01 K_U02 K_U03 K_U08	1 1 1 2

3. Module description

Description	The module aims at acquainting the students with designing, implementing, and diagnosing a local computer network. The module deals with information transfer processes in the three lowest layers of the OSI-7 reference model.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Test	Test involves questions related to the lecture topics.	M_001, M_002
W_002	Short tests.	Tests check the level of understanding of issues concerning computer network development and routing.	M_001, M_004
W_003	Conversation during tasks crediting.	Conversation checks the skill of generalising knowledge gained during completing tasks.	M_003, M_004

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The content is available as multimedia streaming.	15	The students are required to prepare for the test.	15	W_001
Z_002	laboratory classes	The exercises refer to networks joining and LAN networks configuring.	30	The student designs networks with the use of CISCO Packet Tracer.	30	W_002, W_003

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Computer simulations

Module code: W4-INA-S2-20-1-SK

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has skills for creating simulation models.	K_U01 K_U06 K_U08	1 1 1
M_002	The student knows various computer simulation techniques.	K_U08 K_W02	1 1
M_003	The student can implement the concepts in designing simulation experiments.	K_K04 K_U02 K_U03 K_U04 K_U08 K_U09	1 1 1 1 1 1

3. Module description

Description	The module aim is to give students the knowledge necessary for creating simulation models and conducting simulation experiments. The presented topics are related to various computer simulation techniques, simulation software, and simulators' applications in the design and optimisation of technical systems. Students will gain the abilities to build models with the use of simulation environments.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Exam	The two-hour test comprises closed and open-ended questions.	M_001, M_002, M_003
W_002	Reports	The students present reports and discuss developed projects.	M_001, M_002, M_003

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures are supported by multimedia presentations and e-learning	30	The students are required to self-study the literature and materials presented during the lectures.	20	W_001
Z_002	laboratory classes	The assignments have the form of design projects with the use of simulation environments.	30	The students complete the project assignments and prepare the presentations.	40	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Concurrent programming

Module code: W4-INA-S2-20-2-PW

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has extended knowledge of how parallel and concurrent computing work on modern computers.	K_U09 K_W02	1 1
M_002	The student knows the safety properties of concurrent programs and can verify that the given concurrent algorithm is correct.	K_U05 K_U09 K_W02 K_W04 K_W05	1 1 1 1 1
M_003	The student can identify and solve typical problems of concurrent computations.	K_K04 K_U05 K_U09 K_W02 K_W04 K_W05	1 1 1 1 1 1
M_004	The student can assess the effectiveness of a parallel algorithm.	K_U05 K_W02 K_W04	1 1 1

3. Module description

Description	The course aims at introducing the students to the subject of design and implementation of correct and efficient concurrent algorithms. The course emphasises practical aspects of the presented issues and presents the examples of modern programming languages and tools in use.

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Final test.	The test checks the knowledge gained during lectures and laboratory classes. It comprises several closed and (optionally) open-ended questions.	M_001, M_002, M_003, M_004
W_002	Test.	There is at least one mid-term test assessing the knowledge gained by students during laboratory classes.	M_001, M_002, M_003
W_003	Programming assignment.	There is an optional programming assignment checking the programming skills gained during the course.	M_001, M_002, M_003, M_004

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The course comprises material presented in verbal and written forms supplemented with multimedia content. It is mainly focused on more deeply rooted in theory and more complicated issues. The students are encouraged by asking them questions about the content presented during the lectures.	15	The student reads the recommended books and articles, analyse and revise the lecture content and prepares for the final test.	15	W_001
Z_002	laboratory classes	The students prepare to apply the knowledge in programming practice through sample programmes and programming tools. There is a discussion on the method by pointing out the critical operations required to get correct and efficient solutions to typical concurrent programming problems.	15	The student works on assignments and studies the recommended literature.	15	W_002, W_003

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Data analysis in business

Module code: W4-INA-S2-20-F-ADwB

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the average measures, the volatility measures and the asymmetry measures and uses them to perform a descriptive analysis of business data. The student knows the issues of interdependence analysis, correlation and regression analysis to discover business data relationships.	K_W01 K_W09	1 1
M_002	The student has knowledge about classification and regression trees, neural networks, the fundamental and technical analysis used to analyse business and financial data.	K_W09	1
M_003	They make an initial assessment of business data, present it appropriately, and select the model or models suitable for analysis. They can compare the obtained results and draw conclusions based on them.	K_K04 K_U01 K_U08	1 1 1
M_004	They can use the selected program for business data analysis	K_U09	1

3. Module description

Description	Data analysis in business aims at developing statistical population characteristics and use data mining models for business data analysis. The course's goal is also to improve knowledge of classic and modern data analysis techniques on the example of financial data. The list of the topics comprises: 1. Gathering, development, and graphic presentation of data. 2. Elements of business data descriptive analysis. 3. Analysis of correlation, dependence and regression. 4. Application of classification and regression trees for business data analysis. 5. Application of technical and fundamental analysis of financial data. 6. Application of neural networks for business data analysis.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Examination reports	The students prepare written reports and present them orally at a specified time. The presentations are to verify the skills acquired during the problems' solving stage.	M_001, M_002, M_003, M_004
W_002	Test	The students write the test designed to verify their knowledge and skills in solving specific tasks.	M_001, M_002, M_003

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures present the concepts and facts from the curriculum listed in the module and illustrate them with many examples.	15	The student must self-study the content from the lectures and the literature listed in the course syllabus.	15	W_002
Z_002	laboratory classes	The students perform exercises with the teacher's help during the laboratory classes, which develops the skills listed in the module's set of learning outcomes.	30	The students self-improve the skills listed in the module's set of learning outcomes.	60	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Data mining

Module code: W4-INA-S2-20-2-ED

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student is aware of the impact of data mining methods and data types on the quality of knowledge explored.	K_K02	1
M_002	The student knows data types, similarity measures, and classification quality measures.	K_W09	2
M_003	The student knows data preprocessing (discretisation, normalisation, empty data).	K_W09	2
M_004	The student remembers the rules of choosing the right method of exploration depending on the type of input data and expected results.	K_W09	3
M_005	The student can prepare a set for analysis (discretise data, normalise data, fill in empty data).	K_U03 K_U08 K_U09	2 2 4
M_006	The student can implement selected cluster analysis algorithms.	K_U08 K_U09	2 4
M_007	The student can determine the quality of classification	K_U08 K_U09	2 3
M_008	The student has a basic knowledge of association and decision-making rules and approaches to constructing them.	K_U09	2
M_009	The student can present selected algorithms for constructing decision and association rules and their application.	K_W02 K_W09	2 2
M_010	The student has a basic knowledge of feature selection.	K_W09	1
M_011	The student can classify data and interpret the result correctly.	K_W09	3
M_012	The student has a basic knowledge of decision trees and teams of classifiers.	K_W05 K_W09	1 1

M_013	The student can present selected approaches to the construction of decision trees and teams of classifiers.	K_U08	1
M_014	The student has a basic knowledge of the subject and can determine the function of linear regression.	K_U08 K_W01 K_W09	1 1 1
M_015	The student has a basic knowledge of neural networks.	K_W09	1

3. Module description	
Description	The module's goal is to introduce the listener to data mining methods, classification issues, grouping and induction of rules from data. The module comprises: 1. Preliminary concepts 2. Data preprocessing 3. Clustering 4. Basics of classification 5. Feature selection 6. Decision rules 7. Testing statistical hypotheses 8. Association rules 9. Decision trees 10. Classifiers 11. Linear regression 12. Neural networks
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Exam (Test)	The exam verifies the knowledge based on the content presented during the lectures. It comprises both open and closed-ended theoretical questions.	M_001, M_002, M_003, M_004, M_005, M_006, M_007, M_008, M_009, M_010, M_011, M_012, M_013, M_014, M_015
W_002	Projects and reports	The students develop projects with reports for them within a specified period to verify their skills in solving problems.	M_001, M_002, M_005, M_006, M_007, M_008, M_009, M_010, M_011, M_012, M_013, M_014, M_015

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have a verbal form with the use of audiovisual means and other written teaching aids.	30	The lectures prepare for the exam.	15	W_001
Z_002	laboratory classes	The laboratory classes prepare the students to solve tasks by emphasising the proceeding method and the sequence of operations.	30	The student self-studies for the laboratory classes, completes assigned tasks, and prepares the reports.	45	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Data visualization

Module code: W4-INA-S2-20-F-WD

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the use and implementation of data visualisation methods.	K_W02 K_W04 K_W09	1 1 3
M_002	The student knows how and with which methods to process and visualise data and can interpret the results.	K_W04 K_W09	1 2
M_003	The student can select and implement the method of data visualisation.	K_U01 K_U03	1 1
M_004	The student can interpret the result of data visualisation and justify the techniques used.	K_U08 K_U09 K_U10	1 1 1
M_005	The student can implement an automated data visualisation system, working individually or in a team.	K_U02 K_U03 K_U09	1 1 1
M_006	The student is aware of the process of improvement and tracking the latest solutions in data visualisation.	K_K01 K_K03	1 1

3. Module description

Description	The aim of the module is to introduce students with the possibilities of advanced data visualisation with elements of automation using scripting languages such as Python or R.

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Reports	The student prepares written reports within deadlines as verification of skills gained during problem-solving	M_001, M_002, M_003, M_004, M_006
W_002	Project	The students develop individual or group projects and document system data visualisation.	M_001, M_002, M_003, M_004, M_005, M_006

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures are conducted with the use of multimedia tools and discuss the issues related to the data visualisation and its automation in scripting languages.	15	The lectures prepare the student for laboratory classes and passing the exam.	20	W_002
Z_002	laboratory classes	The classes prepare students to perform lab exercises and are a practical presentation of issues discussed during lectures.	30	The student prepares for the laboratory exercises, solves laboratory exercises and prepares the final project.	55	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Data warehouses

Module code: W4-INA-S2-20-F-HDiAM

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows analytical data processing.	K_W09	4
M_002	The student knows the architecture of data warehouses.	K_W02	3
M_003	The student can use tools to prepare data that will feed the warehouse and knows the ETL process.	K_U01 K_W09	4 3
M_004	The student uses tools enabling to perform advanced data analysis, including OLAP.	K_U09 K_W09	4 3
M_005	The student uses specialised tools enabling to create advanced data reports and visualisations.	K_U09	3

3. Module description

Description	The aim of the module is to familiarize students with issues related to architecture of data warehouses, data processing using OLAP technology and advanced reporting tools.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	Knowledge verification is based on the content presented during lectures. It consists of questions regarding considered issues.	M_001, M_002, M_004
W_002	Raport presentation for laboratory tasks	Student prepare a presentation in specified deadline as a verification of skills acquired during implementation of laboratory tasks.	M_001, M_003, M_004, M_005

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are presented in verbal form with the use of audiovisual media and other written educational aids. The students are encouraged by asking them questions and giving basic tasks regarding the considered topics.	15	The students familiarise with the subject of lectures by investigating considered topics.	5	W_001
Z_002	laboratory classes	The classes prepare the students for completing laboratory tasks, emphasising the method and the sequence of operations.	30	The students study for the laboratory tasks, complete them individually and prepare the reports.	70	W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Decision and association rules in knowledge data discovery

Module code: W4-INA-S2-20-F-RDAOW

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows quality measures for knowledge representation as decision and association rules.	K_W09	3
M_002	The student knows approaches and algorithms for construction decision and association rules.	K_W02 K_W04	3 2
M_003	The student can apply decision and association rules in knowledge discovery.	K_U01 K_U03 K_U08 K_W09	4 4 3 3
M_004	The student can choose and present the algorithm for creating a classification model for the considered problem.	K_U08 K_U09	3 3

3. Module description

Description	The module aims at acquainting the students with decision and association rules as models of knowledge representation and classification. The students learn about rule quality measures and approaches and algorithms for their construction and knowledge discovery applications.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The students prepare and present reports in the specified deadline to verify skills gained while completing laboratory assignments.	M_001, M_002, M_003

W_002	Raport presentation for laboratory tasks	The students prepare and present reports in specified deadline as a verification of skills acquired during completing laboratory assignments.	M_001, M_002, M_003, M_004

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have a verbal form using audiovisual media and other written teaching aids. The students are encouraged by asking questions and simple tasks regarding the considered topics.	15	The students get acquainted with the subject of lectures and investigate considered topics.	15	W_001
Z_002	laboratory classes	The classes prepare students for solving problems and complete assignments, emphasising the method and operations sequence.	30	The students study for laboratory classes, complete laboratory tasks and prepare reports.	60	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Decision support systems

Module code: W4-INA-S2-20-F-SWD

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has basic knowledge of decision support systems.	K_K04 K_U01 K_U05 K_U09 K_U10 K_W02 K_W09	1 1 1 1 1 1 1
M_002	The student has basic knowledge in utility theory, the application of deterministic (Hurwicz, Laplace) and non-deterministic criteria (e.g. max. Expected utility) in decision support systems.	K_U01 K_U05 K_U09 K_W02 K_W05	1 1 1 1 1
M_003	The student has basic knowledge of Bayesian networks and their applications in supported decisions	K_U05 K_W01	1 1
M_004	The student has basic knowledge of time series prediction as part of the decision support system.	K_U01 K_W02	1 1
M_005	The student is able to construct decision support systems on the Genie platform based on ordinary and dynamic Bayesian networks, can implement the Java decision support system using the SMILE library.	K_U01 K_U05 K_U08 K_U09	1 1 1 1

		K_U10	1
M_006	The student is able to construct complex decision support systems implemented using the KNIME package, including time series prediction.	K_U01 K_U05 K_U08 K_U09 K_U10	1 1 1 1 1

3. Module description	
Description	The course aims at preparing the students for the design and implementation of decision support systems. Besides the theoretical foundations, the student can implement practical strategies supporting banking, commerce, and others.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Solving decision problems.	The students complete the theoretical tasks, also computational ones.	M_001, M_002, M_003
W_002	Design and implementation of a decision support system.	The students implement the decision support system using the selected platform: 1) Genie/ SMILE 2) KNIME.	M_004, M_005, M_006

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have a form of slides presentations.	15	The students study the lecture notes and compulsory and supplementary literature.	15	W_001
Z_002	laboratory classes	The lecturer presents and discusses examples of decision support systems implemented in Genie, QGenie and KNIME. The students independently develop the systems showed by the teacher. They implement two decision support systems on the Genie/SMILE and KNIME toolkits.	30	The students implement two decision support systems based on the GENIE/SMILE and KNIME toolkits.	60	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Deep learning with neural networks

Module code: W4-INA-S2-20-F-UGzSN

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows methods and algorithms for learning artificial neural networks.	K_W09	1
M_002	The student can design and implement a deep neural network.	K_W02	1
M_003	The student can design and implement a deep neural network.	K_U01	1
M_004	The student can train a neural network to solve a specific machine learning problem.	K_U02	1
M_005	The student can assess the effectiveness of a trained neural network.	K_U05	1
M_006	The student knows the possibilities of modern neural networks and is aware of the importance of machine learning methods in developing modern IT solutions.	K_K01	1

3. Module description

Description	Basics off deep learning and neural networks. Weights' selection methods and activation functions in neural networks. Classification of neural networks due to their structure. Building deep neural networks. Tuning the parameters of NNs. Reinforcement learning in deep learning.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The students solve tasks and answer open-ended questions.	M_001, M_002
W_002	Implementation project	The whole group performs multimedia presentation of their project, which is then self-assessed.	M_003, M_004, M_005
W_003	Multimedia presentation	The self-assessment of collective work is then evaluated, and the hypotheses are verified.	M_006

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are conducted in the verbal form with the use of content visualisation. They are focused on conceptually difficult material and refer to the addresses of useful websites and e-learning package.	15	The student internalises the lectures using the existing packages of methods: the script, websites, and the e-learning package.	30	W_001
Z_002	laboratory classes	The classes thoroughly prepare the students for implementing algorithms, emphasising the method and the sequence of operations.	30	The students study individually for the tests in laboratory classes. They also complete projects – implementations of a chosen system in groups.	45	W_001, W_002, W_003

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Fractal methods in computer graphics

Module code: W4-INA-S2-20-F-MFwGK

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows and understands various types of fractals used in computer graphics, in particular: complex fractals, inversion fractals, iterated function system fractals, L-systems, strange attractors.	K_W01 K_W02	1 1
M_002	The student knows and understands the basic algorithms used in fractal theory, in particular: chaos game, complex fractals rendering algorithms, fractal dimension computation.	K_W04	1
M_003	The student knows and understands mathematical notions used in fractal theory, in particular: contractive mapping, metric, mappings composition, iterative process, dynamical system.	K_W01	1
M_004	The student can get information about fractals and computer graphics from literature, databases and other sources.	K_U01 K_U07	1 1
M_005	The student can work individually and in a team.	K_U02	1
M_006	The student can prepare and perform a presentation on the execution of the project's task.	K_U03 K_U04	1 1
M_007	The student can think and act creatively.	K_K01 K_K03	1 1

3. Module description

Description	The classes introduce the students to the basics of fractal theory and its computer graphics applications, presenting various types of fractals and effective methods of their rendering. The students apply fractal theory in image processing and compression and aesthetics evaluation of both real and synthetic images. During the course, they prepare projects in pairs and perform presentations of their work in front of the group.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Project	The students prepare the project and presentation of the chosen topic connected with fractals.	M_001, M_002, M_003, M_004, M_005, M_006, M_007
W_002	Reports	The students solve sets of tasks.	M_001, M_002, M_003, M_005

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The educational content is presented with the use of audiovisual methods	15	Independent study of lecture topics and given literature.	15	W_001
Z_002	laboratory classes	The classes thoroughly prepare the students to (1) the use of the various fractal methods in computer graphics, (2) the development of alternative approaches. The students complete various programming tasks.	30	The students get acquainted with the subject of classes; they study for the project, prepare it in a team and perform a project presentation.	60	W_001, W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Fuzzy sets nad systems

Module code: W4-INA-S2-20-F-ZiSR

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can explain the concept of fuzzy sets and describe their use in defining imprecise concepts.	K_W01 K_W09	1 1
M_002	The student knows the basic principles of inference in classical logic and their generalisation in fuzzy logic, i.e. fuzzy inference	K_W01	1
M_003	The student can define the structure and knows the principles of fuzzy rule-based systems.	K_W01	1
M_004	The student knows the tools to implement fuzzy systems.	K_W04	1
M_005	The student designs information systems using the ideas of fuzzy sets to address the uncertainty of input data.	K_U08 K_U09 K_U10	1 1 1
M_006	The student implements fuzzy systems using available programming tools.	K_U08 K_U09 K_U10	1 1 1
M_007	The student can assess the importance of using various methods of artificial intelligence in solving specific problems.	K_K01 K_K04	1 1

3. Module description

Description	The classes familiarise the students with the theory of fuzzy sets in terms of flexible representation of uncertain, inaccurate data or preferences. This theory is a ground for introducing the students to the basics of fuzzy inference resulting from classical logic. Ultimately, classes lead to the idea of building and applying fuzzy rule-based systems.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Test	The written test comprises several open-ended questions which relate to the theoretical aspects presented in the lectures.	M_001, M_002, M_003
W_002	Project assignments	The students implement several project tasks assigned by the teacher and document them as a report.	M_004, M_005, M_006, M_007

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures' theoretical content is presented verbally and supported by tools such as classic blackboard or multimedia presentations.	15	The students internalise the content presented during the lecture.	25	W_001
Z_002	laboratory classes	The students discuss the problems and support the teacher during implementing tasks in the computer laboratory.	30	Implementation of tasks presented by the teacher in the computer laboratory.	50	W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: General academic module (Humanities)

Module code: W4-INA-S2-20-3-MOH

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows selected issues related to the subject-related specificity of the humanities, understands their nature, place and importance in the system of sciences, as well as their connections with fields of science and scientific disciplines specific to the studied programme, allowing for the integration of perspectives appropriate for different scientific disciplines.	U_OOD W_OOD	4 4
M_002	The student is able to select, interpret and evaluate knowledge from selected disciplines in the field of humanities and integrate and apply it in scientific activity and professional practice in a manner that allows for original and creative solutions to problems that they experience as participants in cultural life.	U_OOD W_OOD	4 4
M_003	The student is able to creatively undertake, analyse and become involved in current sociocultural discourses, using knowledge of the studied problems of contemporary humanities and acquired communication skills as well as subject- related argumentation that considers various scientific approaches and types of scientific reflection.	U_OOD W_OOD	4 4
M_004	The student, who is a participant in cultural life in its various manifestations, shows the need for continuous learning and improvement of those dispositions that allow to appreciate humanistic reflection and integrate it with issues and experiences resulting from choosing one's own path of scientific and professional activities and related to individual cultural activity.	K_OOD U_OOD W_OOD	3 3 3

3. Module description

Description	The humanistic general academic module allows the student to get acquainted with selected areas of the subject-related specificity of humanities. The student has a chance to compare different methodological and interpretative approaches, and gains knowledge about the benefits of adopting a humanistic perspective of the view of reality. The student learns to implement recognized paradigms of humanistic thinking into their scientific activity, creatively solving the problems posed during the classes. Based on specific cases, the student trains the ability to integrate views appropriate for humanities with the points of view that belong to the fields of science and scientific disciplines appropriate for the studied programme. During the meetings, the student identifies manners of participation in present and future cultural formations, recognizing the paths of individual participation in the life of adequate human communities in the presented and experienced activities.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Test	A written or oral test in accordance with the description of the verification method included in the syllabus.	M_001, M_002, M_003, M_004
W_002	Continuous assessment	Current assessment of the individual work of the student, which is the mean of the grades from the activities conducted during the classes, is consistent with the description of the verification method included in the syllabus.	M_001, M_002, M_003, M_004

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	depending on the choice	Depending on the type of classes, the following methods may be used: expository, problem, task, project methods, the analysis of the source material, etc.	45	Independent and thorough reading of the materials indicated in the syllabus, revision and consolidation of knowledge or skills acquired during classes.	45	W_001, W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: General academic module (Social Sciences)

Module code: W4-INA-S2-20-3-MOS

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows selected issues related to the subject-related specificity of social sciences, understands their nature, place and importance in the system of sciences, as well as their connections with fields of science and scientific disciplines specific to the studied programme, allowing for the integration of perspectives appropriate for different scientific disciplines.	U_OOD W_OOD	3 3
M_002	The student is able to select, interpret and evaluate knowledge from selected disciplines in the field of social sciences and integrate and apply it in scientific activity and professional practice in a manner that allows for original and creative solutions to problems that they experience as participants in social life.	U_OOD W_OOD	3 3
M_003	The student is able to creatively undertake, analyse and become involved in current sociocultural discourses, using knowledge of the studied content, acquired communication skills and subject-related argumentation taking into account various scientific approaches and types of scientific reflection.	U_OOD W_OOD	3 3
M_004	The student, who is a participant in social life in its various manifestations, shows the need for continuous learning and improvement of those dispositions that result from choosing their own path of scientific and professional activities and related to individual social activity.	K_OOD U_OOD W_OOD	2 2 2

3. Module description

Description	The social general academic module allows the student to get acquainted with selected areas of the subject-related specificity of social sciences. The student has a chance to compare different methodological and interpretative approaches, gains knowledge about the benefits of adopting a perspective of reality appropriate for social sciences. Based on specific cases, the student trains the ability to integrate views appropriate for social sciences with points of view that belong to fields of science and scientific disciplines appropriate for the studied programme.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Test	A written or oral test in accordance with the description of the verification method included in the syllabus.	M_001, M_002, M_003, M_004
W_002	Continuous assessment	Current assessment of the individual work of the student, which is the mean of the grades from the activities conducted during the classes, is consistent with the description of the verification method included in the syllabus.	M_001, M_002, M_003, M_004

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	depending on the choice	Depending on the type of classes, the following methods may be used: expository, problem, task, project methods, the analysis of the source material, etc.	30	Independent and thorough reading of the materials indicated in the syllabus, revision and consolidation of knowledge or skills acquired during classes.	30	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: GPGPU computing

Module code: W4-INA-S2-20-F-ONKG

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows GPUs' hardware and graphics cards architecture and the mechanisms and structures of CPU-GPU communication. The student knows parallel algorithms' properties and understands parallelisation techniques in the instructions, data, and tasks.	K_K01 K_U01 K_W03	1 1 1
M_002	The student knows the rules of programming GPUs using CUDA C and understands the DirectCompute library and OpenCL API in parallel processing.	K_K01 K_U01 K_U05 K_U06 K_W02 K_W04 K_W05	1 1 1 1 1 1 1
M_003	The student can work individually or in a team, understands the importance of intellectual honesty in their and other people's activities. They understand the need to improve their competences continually. The student can think creatively, form opinions on fundamental issues, current state and development trends in IT and understands technical issues of professional activity	K_K01 K_K02 K_K03 K_U01 K_U02 K_U03 K_U04 K_W02 K_W04	1 1 1 1 1 1 1 1 1

3. Module description	
Description	The course aims at acquainting the students with the technique of parallel computing on GPUs. The subject course covers CUDA C, DirectCompute and OpenCL, and hardware aspects of calculations on graphic cards.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Project	The semester project shows the learning outcomes adopted in the module.	M_001, M_002, M_003
W_002	Project presentation	The students perform audiovisual presentations in front of the group, discuss the assumptions and adopted methods of solving a specific problem, analyse and assess the implementation of the project goal.	M_003
W_003	Test	The test comprises both open and closed-ended questions.	M_001, M_002

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are conducted with the use of audiovisual means.	15	The students self-study the lecture topics and recommended literature.	30	W_003
Z_002	laboratory classes	The classes are a practical implementation of the learning content from the lectures, including the acquisition of skills and experience of efficient use of CUDA C, DirectCompute or OpenCL libraries. The classes are held with the use of computer stations and appropriate software.	30	The students: 1. Self-study for the laboratory classes. 2. Prepare individual or group projects and document them. 3. Perform the audiovisual presentations on the completed projects and their presentations in front of the group	45	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Image and video processing techniques

Module code: W4-INA-S2-20-F-TPOiV

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows image and video processing.	K_W01 K_W02	1 1
M_002	The student can implement selected algorithms in image and video processing.	K_U01 K_U02 K_U03 K_U04 K_U06 K_U09	1 1 1 1 1 1
M_003	The student can assess and compare the effectiveness of various algorithms for a problem.	K_K01 K_U01 K_U06	1 2 2

3. Module description

Description	The purpose of the module is to introduce the students to modern image and video processing techniques and compression standards.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Written exam	The test is a means of knowledge verification based on the content presented in the lecture.	M_001, M_003

		The exam comprises open-ended theoretical questions.	
W_002	Classes credit	The students present the implementation of the algorithms from the classes and the one individual implementation.	M_002, M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	Transferring the content of education in verbal (or e-learning) form using audiovisual and other teaching aids.	15	The students prepare for the exam.	15	W_001
Z_002	laboratory classes	The classes prepare the students to individual implementation of selected algorithms.	30	The students implement selected algorithms in the programming language of choice.	60	W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Image processing algorithms in biometrics and bioinformatics

Module code: W4-INA-S2-20-F-APOBi

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows and can explain the operation of image processing methods in biometrics and bioinformatics	K_W02	5
M_002	The student can prepare a presentation on the subject.	K_U04	5
M_003	The student can analyse and solve the problems of image processing in biometrics and bioinformatics.	K_U09	5

3. Module description

Description	The course aims at introducing the students to image processing algorithms used in biometrics and bioinformatics.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Written test.	The test comprises theoretical questions concerning the issues discussed in the lectures.	M_001
W_002	Presentation on the assigned topic.	The students prepare presentations related to the lectures.	M_002
W_003	Oral test	The students elaborate on a topic related to image processing in biometrics and bioinformatics.	M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The content of the lecture will be available in	15	The students self-study the issues presented	30	

		the multimedia form, presenting the issues related to the topic.		in the lectures. The students prepare for the exam individually.		W_001, W_002, W_003
Z_002	laboratory classes	During the classes, the students prepare tools for the implementation of design applications and complete tasks specified by the teacher.	30	The students implement a project at home or on computers at the Institute.	45	W_001, W_002, W_003

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Intellectual property protection

Module code: W4-INA-S2-20-3-OWI

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student explains the basic concepts and principles of intellectual property protection	K_W08	4
M_002	The student interprets the provisions related to getting and enforcing protection rights on intellectual property subjects.	K_W08	4
M_003	The student recognises the processes of implementing procedures related to protecting intellectual property.	K_U01	1
M_004	The student creates documentation of intellectual property subjects.	K_U01	1
M_005	The student is aware of the importance of intellectual property protection in professional work and the economy.	K_K03	2

3. Module description

Description	During the lecture, the student becomes familiar with the legal protection of intellectual property objects. Theoretical knowledge transferred concerns concepts in intellectual property, sources of law, and legal protection issues, i.a. works (including computer programs and databases), inventions, utility models, industrial designs, and trademarks. It aims at acquainting the students with copyright protection principles, avoiding infringements of intellectual property, and teach practical skills regarding applications for protecting intellectual property.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	written test	The test covers the fundamental issues of intellectual property protection.	M_001, M_002, M_003
W_002	problem task	The student individually develops a solution to a problem task on a topic in intellectual property protection.	M_002, M_003, M_004, M_005

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The content will be presented as a sequence of information lectures intertwined with problem discussions, paying also attention to issues raised by the students. The particular presentations would be supported by various multimedia means, tools and platforms.	15	The students work with selected subject literature and law regulations, and self-study the knowledge on presented issues presented during lectures. They prepare for the written test and problem task.	45	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Intelligent data processing

Module code: W4-INA-S2-20-F-IPD

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student is aware of intelligent data processing possibilities, especially in large data sets.	K_K02	1
M_002	The student knows the basics of artificial intelligence, including fuzzy logic and fuzzy inference.	K_W02 K_W04 K_W09	2 3 2
M_003	The student has a knowledge of data mining in detecting dependencies and patterns (e.g. rules) in regular and atypical data.	K_W02 K_W04 K_W08 K_W09	1 2 2 4
M_004	The student knows the basics of artificial neural networks and deep learning.	K_W02 K_W04 K_W08 K_W09	2 2 2 3
M_005	The student can implement or manually perform calculations and operations of fuzzification, fuzzy inference and defuzzification.	K_U03 K_U07 K_U08 K_U09	3 2 2 3
M_006	The student can apply the selected rule induction algorithm (e.g. decision trees, association rules) for any data set or detection of unusual cases.	K_U01 K_U03 K_U08	1 3 2

		K_U09	3
M_007	The student knows how to use a dedicated tool to create a neural network model and interpret the developed model's learning results for any data set.	K_U03 K_U07 K_U08 K_U09	3 2 2 3

3. Module description	
Description	The aim is to introduce the student to data mining methods, classification tasks, clustering and rule induction process. It also includes the basics of fuzzy inference or deep learning with elements of neural networks.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Exam (Test)	The exam checks the knowledge gained in the lectures. The test comprises both open and closed-ended theoretical questions.	M_001, M_002, M_003, M_004, M_005, M_006, M_007
W_002	Project reports	The students develop projects with reports within a deadline, which is to verify the skills gained while solving the tasks.	M_001, M_005, M_006, M_007

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The content will be provided in verbal form with support of various audiovisual means and also other teaching aids.	15	The students prepare for the exam.	15	W_001
Z_002	laboratory classes	The classes prepare students to complete tasks with the emphasis on the method and the sequence of operations.	30	The students independently solve tasks assigned to the classes and prepare reports for their projects.	60	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Internet of things technologies

Module code: W4-INA-S2-20-F-TIR

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has the necessary skills for building information and communication technology systems in the Internet of Things.	K_U05 K_W06	1 1
M_002	The student knows standards and protocols used in the Internet of Things.	K_W02 K_W06	1 1
M_003	The student can implement the concepts in real-world applications of the Internet of Things technology.	K_U03 K_U08	1 1

3. Module description

Description	The module’s aim is to give the students knowledge that covers construction, communication methods, and operation of IoT devices. The presented topics cover wireless and wired data exchange technologies, enabling IoT solutions and practical aspects of using smart sensors and actuators in such networks.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Final test	There is a two-hour test which comprises closed and open-ended questions.	M_001, M_002
W_002	Reports	The students present the reports and discuss the developed projects.	M_001, M_003

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are supported by multimedia presentations and e-learning.	15	The students study the literature and other materials presented during lectures.	25	W_001
Z_002	laboratory classes	The classes include assignments as design projects with the use of IoT devices and simulators	30	The students complete project assignments and perform presentations.	50	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Internet protocols

Module code: W4-INA-S2-20-F-PI

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student understands the necessity to implement the particular internet protocols.	K_W03 K_W05 K_W06	3 1 3
M_002	The student characterises TCP/IP protocol stack and understands the need for standardisation of Internet layers and application operation.	K_K04 K_W05 K_W06 K_W07	3 1 3 1
M_003	The student characterises the need to use physical and logical addressing in LAN and WAN networks, understands the need for migration from IPv4 to IPv6 protocols, is aware of threats resulting from this migration, and can explain the necessity of tunnelling IPv6 to IPv4 in the transition period.	K_W03 K_W06	4 3
M_004	The student configures dynamic routing protocols.	K_U08 K_U10	2 1
M_005	The student presents the group with his configuration solutions.	K_K04	1

3. Module description

Description	The module aims at acquainting the students with the use and implementation of network protocols at the L3 and L4 layers of the OSI-7 model.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Lecture test	The test comprises the questions from the subjects of the lectures.	M_001, M_002, M_003
W_002	Tests	The tests check the level of understanding of issues concerning designing the computer network and routing protocols.	M_002, M_003
W_003	Conversation during tasks crediting.	Checks the skill o generalizing knowledge acquired during tasks solution.	M_004, M_005

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The content is available as multimedia streaming.	15	The students prepare for the exam individually.	30	W_001, W_002
Z_002	laboratory classes	During the classes, the blackboard exercises refer to the network addressing and practical exercises refer to routers configuring, reports, and tests.	30	The students design their networks using CISCO Packet Tracer.	45	W_002, W_003

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Introduction to data classificatin and clusterization in biometry

Module code: W4-INA-S2-20-F-WDZKK

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can choose an adequate classification or clustering algorithm to solve a given biometric problem.	K_U03 K_U08 K_U09 K_W01 K_W02 K_W04 K_W05 K_W09	1 1 1 1 1 1 1 1
M_002	The student can design tests for biometric-based identification/verification system.	K_K02 K_K04 K_U01 K_U05 K_U09 K_W04 K_W09	1 1 1 1 1 1 1
M_003	The student can implement primary classification and clustering algorithms used in biometry.	K_U01 K_U02 K_U05 K_U08 K_U09	1 1 1 1 1

		K_U10 K_W01 K_W04 K_W05	1 1 1 1

3. Module description	
Description	The module acquaints the student with the basic algorithms for classification and clustering of data used in biometric systems.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Short test	The short test in a traditional form (or on-line test) verifies knowledge from the lecture and laboratory classes.	M_001, M_002
W_002	Project	The student prepares the biometric system or test environment for the biometric system, with technical documentation.	M_001, M_002, M_003
W_003	Final test	The student writes the final test covering the whole topic.	M_001, M_002, M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are conducted using multimedia presentations in a traditional and e-learning form.	15	The students should study auxiliary materials and literature.	15	W_003
Z_002	laboratory classes	The project/lab classes take place in the computer laboratory and as e-learning.	30	The students study the literature and on-line materials and prepare the projects.	60	W_001, W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Introduction to reverse engineering

Module code: W4-INA-S2-20-F-WDIW

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows and can explain the operation of advanced mechanisms used in high- and low-level languages.	K_W02 K_W04	5 5
M_002	The student can prepare a presentation devoted to advanced programming issues.	K_U04	5
M_003	The student is able to analyse a computer program using tools such as a debugger and disassembler.	K_U09	5

3. Module description

Description	The course aims at introducing the students to reverse engineering. Students will use popular and free disassemblers, such as IDAPro, to the analysis of different program types, for example computer viruses, and malware. The program of the course includes: - use of reverse engineering tools, - reverse engineering of binary files, - introduction to code analysis, - analysis and reimplementation of simple programs, - analysis of viruses and malware.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Written test.	The test comprises theoretical questions concerning the issues discussed in the lecture.	M_001
W_002	Presentation of the assigned topic	The students prepare presentations related to the subject of reverse engineering.	M_002

W_003	Oral test	It is a discussion on how a given computer programme works.	M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The content of the lecture will be available in the multimedia form with some sample project tasks.	15	The students study the topics presented in the lectures and prepare for the exam individually.	30	W_001, W_002, W_003
Z_002	laboratory classes	During the classes, the students prepare design tools and complete tasks specified by the teacher.	30	The students implement projects at home or on computers at the Institute.	45	W_001, W_002, W_003

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Introduction to scientific research.

Module code: W4-INA-S2-20-1-WDBN

1. Number of the ECTS credits: 1

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	Initiating scientific research.	K_K01	1
		K_K02	1
		K_K03	1
		K_K04	1
		K_K05	1
		K_U01	1
		K_U02	1
		K_U06	1
		K_W07	1
		K_W08	1

3. Module description

Description	The course aims at acquainting students with the offer of scientific research carried out in the Institute of Computer Science.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Report	The students prepare brief reports on the selected topic of the research work.	M_001

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	seminar	The educational content in presented verbally with the use of content visualisation.	2	The students take part in meetings carried out by research groups.	28	W_001

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: IT for the blind and visually impaired

Module code: W4-INA-S2-20-3-T

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student is aware of the problems and existing solutions for the availability of IT applications	K_W07	1
M_002	The student can assess the problems of IT solutions in users with visual impairments and propose solutions.	K_U05	1
M_003	The student applies the principles of available (universal) IT system design and makes others aware of it.	K_K02 K_K05	1 1

3. Module description

Description	The classes introduce IT problems in blind and visually impaired users. The students learn the WCAG requirements necessary to create and implement IT solutions. They also learn about tools (both hardware and software) available for blind and visually impaired people.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The test has a form of several questions regarding the presented issues.	M_001, M_002, M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are verbal presentations of the	15	The students study the content provided	45	W_001

		subject content supported by multimedia materials and software and hardware demonstration.		during the lecture and as shared materials.		

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Machine learning in biometrics and bioinformatics

Module code: W4-INA-S2-20-F-UMwBB

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can solve problems individually or in a team, using the gained knowledge and practical skills.	K_K01 K_K03 K_K04 K_U01 K_U02	1 1 1 1 1
M_002	The student can analyse any biometric system to use the machine learning algorithm.	K_U01 K_U08 K_U09 K_W01 K_W02 K_W04 K_W05 K_W09	1 1 1 1 1 1 1 1
M_003	The student has in-depth knowledge of contemporary methods of artificial intelligence.	K_U01 K_W01 K_W02 K_W05 K_W09	1 1 1 1 1
M_004	The student knows selected neural network architectures.	K_W01 K_W04	1 1

		K_W09	1
M_005	The student can implement machine learning models for data classification and regression problems in biometrics and bioinformatics using the software libraries.	K_W01 K_W02 K_W04 K_W05 K_W09	1 1 1 1 1
M_006	The student can test the advancement of his work or teamwork and refer to it.	K_U03 K_U04 K_U05	1 1 1
M_007	The student is familiar with the current state and the latest developments and trends in computer science, including artificial intelligence and machine learning methods and their biometrics and bioinformatics applications.	K_W01 K_W02 K_W09	1 1 1

3. Module description	
Description	The course aims at acquainting the students with machine learning algorithms, with particular emphasis on their applications in biometrics and bioinformatics. It includes the discussion on different learning methods with and without supervision. The primary element of the course are methods based on neural networks.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The students solve a theoretical test related to the topics discussed in the lectures.	M_003, M_004, M_007
W_002	Project documentation	The students presentat a full documentation of the project, including all stages of its implementation.	M_001, M_002, M_003, M_004, M_005, M_006, M_007

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are conducted verbally with the use of content visualisation, emphasising the material particularly difficult to understand. The students are encouraged by asking questions about the content. The classes have both traditional and e-learning form.	15	The students prepare for the test.	10	W_001
Z_002	laboratory classes	During the laboratory classes, the students learn about mathematical models of machine learning and solve tasks in this field. The classes have both a traditional and e-learning form.	30	The students complete tasks from individual topics with analysis of existing solutions.	65	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Managing IT projects and teams

Module code: W4-INA-S2-20-2-ZZiP

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the various methodologies of managing IT projects, primarily project team management, resources, risks, efficiency and quality. The student uses specialist literature.	K_U07 K_W05	2 5
M_002	The student works in a team, uses available IT tools to help manage the project, and understands PM certification.	K_K01 K_U02 K_U03	1 5 3
M_003	The student can present the effects of teamwork.	K_U04	1

3. Module description

Description	The module includes issues related to projects and project management methodologies. The topics are project teams, problems of their creation, functioning, development, evaluation, and management of their work. In particular, the content concerns IT project management methodologies, starting with the project's components and resources. Specific attention is paid to planning, scheduling, risk management, efficiency, and quality. During the laboratory classes, the students use several available IT solutions, particularly project management packages, to manage a complex project. Depending on the availability of licences, it could be, for example, MS Project.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Lecture test	The test is in written or oral form (with open or closed-ended questions).	M_001
W_002	Practical tasks	The student should fill the task card. The card is the documentation of every task described on it and completed by the student. It is the basis for passing the classes. There is also a	M_002

		practical task completed in the project team, in which the students show their roles, schedule, and preparation of the report.	
W_003	Project team presentation	The project team presents its organisation (method, roles), IT project, schedule, resources, etc.	M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures present the chosen issues involving audiovisual aids and include methods, reports, and certification plans.	10	The students study the supplementary literature.	5	W_001
Z_002	laboratory classes	The classes are workshops with specified subsequent tasks. They include project task executed in project teams, discussions and presentations of results.	20	The students gather practical information necessary to implement the project in a project team and gain proficiency in using IT tools.	25	W_002, W_003

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Master's seminar I

Module code: W4-INA-S2-20-1-SMI

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can use the literature to prepare elaboration referring to the Master's thesis.	K_U01 K_U07	2 2
M_002	The student can prepare work-plan defining timelines and activities connected with subsequent thesis writing stages.	K_U01 K_U02	1 1
M_003	The student can edit and plan direct and indirect aims of the Master's thesis.	K_U01	1
M_004	The student can summarise necessary information connected with the thesis range and describe the problem discussed in the Master's thesis.	K_U04	1
M_005	The student can present their work and provide its thematic range, emphasising the most critical issues.	K_U04	1
M_006	The student can answer questions referring to the thesis and defend in the confrontation with other students their opinions on subjects discussed and the solutions of the problems presented in it.	K_U01 K_U04	1 1
M_007	The student can negotiate and organise work, which is the ability of self-evaluation and self-organisation.	K_U05 K_U06	1 1

3. Module description

Description	The seminars aim at preparing the students to correct planning and executing all the tasks necessary to write the Master's thesis. As a result, the student should present their ideas clearly and justify the suggested approach to the thesis problems described, also in a confrontation with other people.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Presentations	The students present subsequent stages of the Master's thesis realisation as periodic reports. These presentations will allow systematic verification of the students' work progress.	M_001, M_002, M_003, M_004, M_005, M_006, M_007
W_002	Articles analyses	The students present opinions about the chosen scientific articles connected with the thesis topic. It will allow them to get acquainted with different approaches to the thesis subject and develop critical insight into the solutions used.	M_004, M_005, M_006, M_007

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	seminar	The seminar aims at specifying thoroughly scientific papers writing principles, discuss and prepare work and thesis writing plan.	15	The students should work creatively, analyse the literature thematically close to their Master's theses. The next step is to prepare the thesis plans and contents, and ultimately write final versions of their theses. The students should do meticulous analyses of the chosen scientific literature, prepare summaries and draw their own conclusions.	45	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Master's seminar II

Module code: W4-INA-S2-20-2-SMII

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can use the literature to prepare elaboration referring to the Master's thesis.	K_U01 K_U07	2 2
M_002	The student can prepare a work defining timelines and activities connected with subsequent thesis writing stages.	K_U01 K_U02	1 1
M_003	The student can edit and plan direct and indirect aims of the Master's thesis.	K_U01	1
M_004	The student can summarise necessary information connected with the thesis range and describe the problem discussed in the Master's thesis.	K_U04	1
M_005	The student can present his work and provide its thematic range, emphasising the most critical issues.	K_U04	1
M_006	The student can answer questions referring to the thesis and defend in the confrontation with other students their opinions on subjects discussed and the solutions of the problems presented in it.	K_U01 K_U04	1 1
M_007	The student can negotiate and organise their work: the ability of self-evaluation and self-organisation.	K_U05 K_U06	1 1
M_008	The student can critically assess their activities to test and improve work effects.	K_K02 K_K03 K_U05	1 1 1

3. Module description

Description	The seminars aim at preparing the students to correct planning and executing all the tasks necessary to write the Master's thesis. As a result, the student should present their ideas clearly and justify the suggested approach to the thesis problems described, also in a confrontation with other people.

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Presentations	The students present subsequent stages of the Master's thesis realisation as periodic reports. These presentations will allow systematic verification of the students' work progress.	M_001, M_002, M_003, M_004, M_005, M_006, M_007, M_008
W_002	Articles analyses	The students present opinions about the chosen scientific articles connected with the thesis topic. It will allow them to get acquainted with different approaches to the thesis subject and develop critical insight into the solutions used.	M_004, M_005, M_006, M_007, M_008

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	seminar	The seminar aims at specifying thoroughly scientific papers writing principles, discuss and prepare work and thesis writing plan.	30	The students should work creatively, analyse the literature thematically close to their Master's theses. The next step is to prepare the thesis plans and contents, and ultimately write final versions of their theses. The students should do meticulous analyses of the chosen scientific literature, prepare summaries and draw their own conclusions.	30	W_001, W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Master's seminar III - thesis preparation

Module code: W4-INA-S2-20-3-SMIII

1. Number of the ECTS credits: 9

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can present a full written elaboration concerning the Master's thesis.	K_K04 K_K05 K_U01	1 1 1
M_002	The student can summarise necessary information connected with the thesis range and describe the problem discussed in the Master's thesis.	K_K04 K_U01 K_U04	1 1 1
M_003	The student can present his work and provide its thematic range, emphasizing the most critical issues.	K_U01 K_U04	1 1
M_004	The student can answer questions referring to the thesis and defend in the confrontation with other students their opinions on subjects discussed and the solutions of the problems presented in it.	K_K05 K_U04	1 1
M_005	The student understands the importance of intellectual honesty in their and other people's activities and acts ethically.	K_K03	2
M_006	The student understands the need for presenting achievements in IT by editing and publishing their Master's thesis.	K_K05	2
M_007	The student can critically assess their activities to test and improve work effects.	K_U05	2

3. Module description

Description	The seminars aim at preparing the students to correct planning and executing all the tasks necessary to write the Master's thesis. As a result, the student should present their ideas clearly and justify the suggested approach to the thesis problems described, also in a confrontation with other people.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Presentations	The students present subsequent stages of the Master's thesis realisation as periodic reports. These presentations will allow systematic verification of the students' work progress.	M_002, M_003, M_004, M_005, M_007
W_002	Master thesis	The students write an elaboration of the Master's thesis, which is to verify their skills.	M_001, M_005, M_006

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	seminar	During the seminars, parts of the master theses being prepared are presented and discussed, to share the results and experience among the participants.	30	The students internalise materials connected with the Master's theses subjects, present their elaborations and prepare the final versions of their Master's theses. The students prepare for the discussions.	240	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Master's workshop I

Module code: W4-INA-S2-20-2-PMI

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can define requirements referring to the Master's thesis between its form and technical editing.	K_U01	1
M_002	The student can prepare documentation connected with the Master's thesis.	K_U03	1
M_003	The student can use IT tools for a correct edition of the Master's thesis and understand the need to make substantive and visual corrections.	K_U09	1
M_004	The student can use statistical methods for verification of hypotheses presented in the Master's thesis.	K_U08 K_W01	1 1
M_005	The student can use IT techniques in the specified area of use in the Master's thesis or the realised project.	K_U09	1
M_006	The student can present results connected with work to a group of people and exhibit creative thinking abilities while solving encountered problems.	K_U04	1

3. Module description

Description	The seminar aims at preparing the students for the correct edition of the Master's thesis, including its technical part. The student should present their thesis documentation appropriately and use the techniques learnt to compare to other known solutions similar to questions analysed in the thesis. They should also know the principles of the correct Master's thesis edition and IT tools supporting this process
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Presentations	The students present subsequent stages of the Master's thesis realisation as periodic reports. These presentations will allow systematic verification of the students' work progress.	M_001, M_003, M_004, M_005, M_006

W_002	Additional project	The students prepare additional project related to the Master's thesis subject. During its realisation, the student can show the ability to self-organise and their timeliness. They will also gain the knowledge necessary to write a Master's thesis.	M_002, M_003, M_004, M_005, M_006

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	laboratory classes	The classes include a detailed specification of technical aspects associated with the Master's thesis writing and a review of the most popular tools helpful in the Master's thesis editing and preparing and project documentation.	45	The students get acquainted with tools and their use in the Master's thesis writing, creating projects and preparing presentations.	45	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Master's workshop II

Module code: W4-INA-S2-20-3-PMII

1. Number of the ECTS credits: 5

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can define requirements referring to the Master's thesis between its form and technical editing.	K_U01	1
M_002	The student can prepare documentation connected with the Master's thesis.	K_U03	1
M_003	The student can use IT tools for a correct edition of the Master's thesis and understand the need to make substantive and visual corrections.	K_U09	1
M_004	The student can use statistical methods for verification of hypotheses presented in the Master's thesis.	K_U08 K_W01	1 1
M_005	The student can use IT techniques in the specified area of use in the Master's thesis or the realised project.	K_U09	1
M_006	The student can present results connected with work to a group of people and exhibit creative thinking abilities while solving encountered problems.	K_U04	1

3. Module description

Description	The seminar aims at preparing the students for the correct edition of the Master's thesis, including its technical part. The student should present their thesis documentation appropriately and use the techniques learnt to compare to other known solutions similar to questions analysed in the thesis. They should also know the principles of the correct Master's thesis edition and IT tools supporting this process.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Presentations	The students present subsequent stages of the Master's thesis realisation as periodic reports. These presentations will allow systematic verification of the students' work progress.	M_001, M_003, M_004, M_005, M_006

W_002	Documentation	The student should present full documentation of the application if it is such in the thesis and the documentation of experiments carried out or other research conducted as part of the Master's thesis.	M_002, M_004, M_006

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	laboratory classes	The classes include a detailed specification of technical aspects associated with the Master's thesis writing and a review of the most popular tools helpful in the Master's thesis editing and preparing and project documentation.	45	The students get acquainted with tools and their use in the Master's thesis writing, creating projects and preparing presentations.	105	W_001, W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Mathematical modeling of optimization problems

Module code: W4-INA-S2-20-3-MMPO

1. Number of the ECTS credits: 3

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can use selected programming libraries to plan combinatorial optimisation problems as a linear programme (also integer programme).	K_U01 K_U05 K_U08 K_U09	1 1 3 3
M_002	The student can solve a combinatorial optimisation task using modern search methods, such as Answer Set Programming and Satisfiability Modulo Theories, in a selected programming language.	K_U01 K_U05 K_U08 K_U09	1 3 3 3
M_003	The student knows planning combinatorial optimisation tasks through classical and modern mathematical modelling methods.	K_W01 K_W02 K_W04 K_W09	4 3 1 1

3. Module description

Description	This module aims at the exact and effective solving of intractable optimisation problems. The students get acquainted with the following three approaches: 1.Linear and integer programming (for example MathProg language) 2.Satisfiability Modulo Theories (for example based on Z3 library) 3.Answer Set Programming (for example AnsProlog) Thanks to that every student should know all aspects of using classical and modern exact optimisation methods.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Credit for the lecture	The student should complete the executing assignments involving all approaches described in the lectures.	M_003
W_002	Credit for the laboratory classes	The student should complete programming assignments that involve classical and modern combinatorial optimisation problems, with the help of glpk and Z3 libraries and AnsProlog language.	M_001, M_002

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures are oral presentations supported by slideshows, focusing primarily on the most demanding topics, giving basic examples and suggesting web pages for more advanced students.	15	The students get acquainted with the topics, appropriate software, selected web pages and recommended literature.	30	W_001
Z_002	laboratory classes	The classes prepare students for executing assignments by showing the method and sequence of operations.	15	The students write computer programmes and the analysis of existing solutions on the Internet.	30	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Methods of group decision making

Module code: W4-INA-S2-20-F-MPDG

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the topology and architecture of multiple classifier systems, building combined classifiers and techniques for the fusion of based models' predictions.	K_W02 K_W05 K_W09	1 2 1
M_002	The student knows the fundamental issues related to two-player and n-player games, i.e. the payoff matrix, the Nash equilibrium and the Shapley value.	K_W01	1
M_003	The student can choose appropriate architecture and topology of multiple classifier systems to the considered problem. They can carry out the process of building combined classifiers and apply the proper fusion method.	K_U03 K_U08 K_U09	1 1 1
M_004	The student can use the selected programme to perform the analysis using multiple classifier systems.	K_U09	1

3. Module description

Description	The course aims at presenting issues related to multiple classifier systems and fusion methods used when making group decisions. The subject will also cover selected topics from game theory. Content: 1. Topology and architecture of multiple classifier systems. 2. Methods of constructing combined classifiers: Bagging, Boosting, methods of selecting variables. 3. Methods for combining base classifiers' prediction results: fusion methods from the abstract, rank and measurement levels. 4. The problem of diversity of base models. 5. Introduction to the two-player games, payoff matrix and the Nash equilibrium. 6. Introduction to the n-player games and the Shapley value.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Examination reports	The student should prepare written reports and their oral presentation in the specified time to verify skills obtained during problems' solving.	M_001, M_002, M_003, M_004
W_002	Test	The test verifies the knowledge and skills based on the analysis of tasks completed.	M_001, M_002, M_003

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures present concepts and facts listed in the module and illustrate them with numerous examples	15	The students self-study the content of the lectures and the literature	15	W_002
Z_002	laboratory classes	During the laboratory classes, the students perform exercises with the teacher's help, which develops the skills listed in the module's set of learning outcomes.	30	The students improve the skills listed in the set of learning outcomes of the module.	60	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Microcomputers and network couplers

Module code: W4-INA-S2-20-F-MiSS

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student describes the advantages of Harvard-architecture microcomputer and reduced instruction set (RISC).	K_W03 K_W06 K_W09	1 1 1
M_002	The student presents various concepts of microcontrollers networks.	K_W03 K_W06	3 2
M_003	The student understands threats associated with maintenance-free control of manufacturing processes	K_W03 K_W05 K_W09	2 1 1
M_004	The student uses runtime systems for microcomputers.	K_U01 K_U08 K_U09	1 1 1

3. Module description

Description	The module aims at presenting the concept of communicating networks and cooperating microcontrollers. The student learns two microcontrollers families and justifies optimum solutions analysing widely perceived cost (equipment cost, energy consumption, simplicity of implementation, etc.).
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Lecture test	The test includes questions from the lectures	M_001, M_002, M_003
W_002	Conversation during completing tasks	The conversation checks the generalisation skill acquired while completing tasks in pairs.	M_004

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The content is available in the form of multimedia streaming.	15	The students prepare for the laboratory classes and to the lecture test.	15	W_001
Z_002	laboratory classes	The classes consist of writing simple programmes for microcomputer using the chosen programming language and runtime environment. The students design and activate microcomputer-controlled devices.	30	The students activate programmes dedicated to the designed microcomputer-based device and prepare a specification for the developed device.	60	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Mobile systems and applications

Module code: W4-INA-S2-20-F-SiAM

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the field of mobile systems programming and using standard modules of mobile devices.	K_W02	1
M_002	The student knows the field of designing graphical user interfaces for mobile applications.	K_U10 K_W05	1 1
M_003	The student can select an appropriate programming language and environment for programming a device and operate mobile devices' emulators.	K_W04	1
M_004	The student designs and implements mobile devices applications according to the given specification (having particular functionality).	K_U10 K_W03	1 1
M_005	The student independently gets acquainted with issues, also beyond the field of study, enabling them to participate in interdisciplinary projects.	K_K01 K_U01 K_U05 K_U06	1 1 1 1
M_006	The student can prepare documentation for a project task.	K_U03	1
M_007	The student presents their work results, software functionality, can justify selected solutions and draw the correct conclusions.	K_U04	1

3. Module description

Description	This module aims at preparing students to create applications for mobile devices. As a result, the student should exhibit knowledge in the field of construction and hardware capabilities and programming capabilities of mobile devices. The students should also be familiar with wireless data transfer issues and the principles of operating the GPS and other modules typical for mobile systems and devices. Consequently, this should lead to an acquisition of an intricate knowledge enabling to create applications for mobile devices of various types.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Project task - mobile app	The task is to design, implement, launch and test a mobile application with a functionality accepted by the teacher	M_001, M_002, M_003, M_004, M_005, M_006
W_002	Presentation and discussion on the implementation of the project task	The discussion includes questions testing the understanding of issues related to the mobile device's construction and operating, allowing its programming. It is a way of verification of the ability to generalise the skills gained while implementing the task.	M_001, M_002, M_003, M_005, M_007

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures are for describing principles and discussion. The material is available as multimedia content. Online courses and pieces of training are available on some e-learning platforms.	15	The students get acquainted with the materials shared online. They complete the selected online course, previously accepted by the teacher, and prepare for passing the course.	15	W_002
Z_002	laboratory classes	During the classes, the students design, implement, run and test sample mobile applications. After that, they present their work effects and discuss the applied solutions.	30	The students design, implement, run and test a project task. They get acquainted with the project task's specification, prepare for laboratory classes and prepare the documentation and presentation of the project task.	60	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Modern programming languages

Module code: W4-INA-S2-20-1-NJP

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can choose and implement the relevant structure in the programming language.	K_K01 K_U01 K_U04 K_W04	1 2 1 2
M_002	The student can describe algorithms using selected programming language structures.	K_K01 K_U04 K_W01 K_W02	1 1 3 3
M_003	The student knows the programming language.	K_U04 K_U06 K_W02 K_W04	1 1 2 2

3. Module description

Description	Kotlin is a first-class language for programmers. Based on Kotlin, the following comparisons will be made: Kotlin vs Python, Kotlin vs Java, Kotlin vs JavaScript. Accordingly, it will be shown that Kotlin is an effective programming language. The course comprises the following topics: •Kotlin for Server Side, Android JavaScript, Native, Data Science programming. •Basic syntax, idioms and coding conventions. •Basic types, packages and imports. •Classes and objects.

	•Functions, lambdas and inline functions. •Collections. •Coroutines. •Multi-platform programming. •Core libraries. •Kotlin for Java and JavaScript. •Native programming.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Written test	The exam is designed to verify the knowledge presented in the lectures in the form of a written test	M_001, M_002, M_003
W_002	Project exercises	The students submit projects (applications) within a specified period to verify skills gained during problem-solving.	M_001, M_002, M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are carried out by using audiovisual means.	30	The students study lecture topics basing on books and materials from the Internet.	15	W_001
Z_002	laboratory classes	The classes are compulsory and take place in the computer lab according to the schedule.	30	The students solve practical tasks, develop and practice the implementation of projects.	45	W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Monographic lecture

Module code: W4-INA-S2-20-1-WM

1. Number of the ECTS credits: 1

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the major research trends in computer science such as machine learning, biometrics, computer networks and graphics, data analysis, and decision support systems.	K_W02	1

3. Module description

Description	This monographic lecture acquaints the students with scientific research conducted in our faculty on computer science and telecommunication. Every research group performs a 4-hour presentation of primary methods and ideas used in their study with potential application in the Master's theses
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Lecture examination	The student should select a supervisor, determine the topic of their thesis, and show the essential knowledge on the subject by writing an introduction of the thesis.	M_001

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are oral presentations supported with prepared slides. They focus primarily on the most demanding parts of the material, giving basic examples and	20	The students get acquainted with the material from the lectures, selected web pages, and recommended literature.	10	W_001

		suggesting web pages for more advanced students.				

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Monographic lecture - Combinatorial machine learning

Module code: W4-INA-S2-20-2-WMwJA

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can recognise analogies in the knowledge presented in the lecture and the concepts employed out in other courses.	K_U01 K_W02	4 2
M_002	The student knows the decision rules, decision trees and reducts, and can provide examples of their application to solving real problems.	K_U07 K_W09	4 3
M_003	The student can present an algorithm for construction decision rules, decision trees, and tests.	K_W02 K_W04	3 1
M_004	The student can present the problem of construction rules, trees, and tests as an optimisation problem.	K_U08 K_W02	2 2

3. Module description

Description	The aim is to acquaint students with decision trees, decision rules and tests as tools for discovering knowledge from data. Subsequently, the students will analyse them, study relationships between these objects, and show examples of their applications.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The test verifies the knowledge presented during the lectures.	M_001, M_002, M_003, M_004
W_002	Completing assignments	The students present, in the specified term, results of completed assignments as verification	M_003, M_004

		of skills.	

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have a verbal form using audio-visual media and other written teaching aids, emphasising issues more difficult to understand. The students are encouraged by asking them questions and giving them simple tasks regarding the considered topic.	30	The students get acquainted with the lectures, analyse the discussed content for the links between the studied objects, and complete the tasks related to the lectures.	30	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Network systems security

Module code: W4-INA-S2-20-F-BSS

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student understands the need to protect network devices.	K_W03	3
M_002	The student understands the need to encrypt and tunnelling transmission on the Internet, i.e. IPSec, SSL, VPN.	K_W03 K_W06	2 2
M_003	The student understands the need to limit user access to network resources, i.e. AAA (authentication, authorisation and accounting).	K_W03 K_W06 K_W08	1 1 1
M_004	The student can implement a network firewall.	K_K02 K_U08 K_U10	1 2 1
M_005	The student can analyse network traffic.	K_U01 K_U08 K_U09	1 2 1

3. Module description

Description	The module's aim is acquainting the students with issues associated with designing and operation of secure computer networks and behaviour-based security.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Module test	The test comprises questions from the lecture subject.	M_001, M_002, M_003
W_002	Conversation during tasks examination	The conversation checks the skill of generalising knowledge gained during tasks solving.	M_004, M_005

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The content is available as multimedia streaming.	15	The students prepare for the test.	30	W_001
Z_002	laboratory classes	The exercises refer to network security and LAN networks configuring.	30	The students design and implement a firewall.	45	W_002

1.	Field of study	Computer Science
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Object-relational database systems in biometry

Module code: W4-INA-S2-20-F-RSBwB

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has essential knowledge on designing object-relational database systems for biometry.	K_U03 K_U10 K_W02 K_W03 K_W05	1 1 1 1 1
M_002	The student can choose suitable technical tools for solving a problem.	K_K02 K_U01 K_U02 K_U05 K_U06 K_U08 K_U10 K_W03 K_W04 K_W06	1 1 1 1 1 1 1 1 1 1
M_003	The student can prepare technical documentation for a system.	K_U03 K_U04	1 1

3. Module description

Description	This module prepares the student for development of database systems dedicated for biometric systems.

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Short test	The short traditional or on-line test verifies knowledge gained in the lectures and laboratory classes.	M_001, M_002
W_002	Passing project	The students prepare the biometric database system project and system documentation.	M_001, M_002, M_003
W_003	Passing test	The students pass the test covering the whole subject.	M_001, M_002, M_003

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures are conducted with the use of multimedia presentations both in a traditional and e-learning form.	15	The students should study the supplementary materials and literature.	15	W_003
Z_002	laboratory classes	The project/laboratory classes are held in the computer laboratory and as e-learning.	30	The students study the literature and on-line materials and prepare a passing project.	60	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Outlier detection algorithms

Module code: W4-INA-S2-20-F-AWOwD

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student is aware of the essence of deviations in the data, which are not errors in the data but real different objects.	K_K02	1
M_002	The student knows the basics of descriptive statistics, including issues to identify deviations in data.	K_W04 K_W09	3 2
M_003	The student knows methods of graphical data representation and detection of deviations in such representations.	K_W09	3
M_004	The student knows selected deviation detection algorithms, including algorithms based on distance and data distribution, and algorithms based on data density or local deviations.	K_W02 K_W04 K_W09	2 2 3
M_005	The student can choose the right algorithm to detect deviations depending on the type of analysed data	K_U01 K_U03 K_U08 K_U09	2 2 2 2
M_006	The student can implement or use ready-made libraries/packages that allow a deviation detection algorithm for a selected data set.	K_U01 K_U03 K_U08 K_U09	2 2 2 4
M_007	The student can determine the similarity/distance between two objects in multidimensional space.	K_U01 K_U03 K_U08 K_U09	2 2 2 3

3. Module description

Description	The goal is to introduce the listener to deviation detection algorithms so important in practical applications, e.g. for detecting embezzlement or unusual disease symptoms. Among the issues raised, there will be algorithms based on the distance between objects in the analysed space and algorithms derived from cluster analysis allowing identification of unmatched and ungroupable objects.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Exam (Test)	The test verifies knowledge based on the content presented in the lectures. The exam comprises both open and closed-ended theoretical questions.	M_001, M_002, M_003, M_004, M_005, M_006, M_007
W_002	Projects and reports	The students develop projects and write reports within a specified period to verify their skills in solving problems.	M_001, M_005, M_006, M_007

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have verbal form and involve using audiovisual means and other written teaching aids.	15	The students prepare for the exam.	15	W_001
Z_002	laboratory classes	The classes thoroughly prepare the students to solve tasks, emphasising the method and the sequence of operations.	30	The students prepare for the laboratory classes, complete the assigned tasks and write reports.	60	W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Procedural content generation

Module code: W4-INA-S2-20-F-PGT

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows and understands the basic classes of procedural content generation methods such as pseudo-random numbers generators, generative grammars, spatial algorithms, images filtering.	K_W02 K_W04	1 1
M_002	The student knows and understands the basic algorithms and data structures used in the procedural content generation such as quadtrees, BSP trees, graph search algorithms, Voronoi diagrams.	K_W04	1
M_003	The student knows and understands mathematical notions used in the procedural content generation such as partial derivative, graph, linear and non-linear functions of one and multiple variables, fractal.	K_W01	1
M_004	The student can get information about procedural content generation methods from literature, databases and other sources.	K_U01 K_U07	1 1
M_005	The student can work individually and in a team.	K_U02	1
M_006	The student can prepare and present a presentation on the completion of the project's task.	K_U03 K_U04	1 1
M_007	The student can think and act creatively.	K_K01 K_K03	1 1

3. Module description

Description	The module aims at introducing the procedural content generation's basics methods to the students, e.g. levels, music, models, etc. Besides these methods, they will get acquainted with the ways of procedural generators evaluation. During the course, they will also prepare and present projects in pairs in front of the group.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Project	The students prepare the project and presentation of the chosen topic connected with procedural content generation.	M_001, M_002, M_003, M_004, M_005, M_006, M_007
W_002	Reports	The students solve the sets of tasks.	M_001, M_002, M_003, M_005

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures present the educational content with the use of audiovisual methods	15	The students self-study the lecture topics and recommended literature.	15	W_001
Z_002	laboratory classes	The classes thoroughly prepare the students to (1) the use of various content generation methods, for instance, in computer games, (2) the development of alternative approaches. The students solve programming tasks.	30	The students get acquainted with the laboratory classes' subjects and the project's matters, prepare them in teams and perform their projects' presentations.	60	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Real-time graphics

Module code: W4-INA-S2-20-F-GCR

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows and understands the principles of real-time graphics, in particular: programmable graphics pipeline, transform feedback transformation, computational shaders.	K_W02 K_W04	1 1
M_002	The student knows and understands mathematical notions used in real-time graphics, in particular: cross product, dot product, normal vector, partial derivative, linear interpolation, matrix computations.	K_W01	1
M_003	The student knows and understands the physical notions used in real-time graphics, in particular: Snell's law, the law of reflection, the fundamental equations of kinematics.	K_W01	1
M_004	The student can use tools that support shaders' writing process and tools for profiling graphical applications.	K_U09	1
M_005	The student can get information about real-time graphics from literature, databases and other sources.	K_U01 K_U07	1 1
M_006	The student can work individually and in a team.	K_U02	1
M_007	The student can prepare and present a presentation on the completion of the project's task.	K_U03 K_U04	1 1
M_008	The student can think and act creatively.	K_K01 K_K03	1 1

3. Module description

Description	The classes aim to introduce the graphics generated in real-time to the students using GPU (Graphics Processing Unit). For this aim, the students will use libraries such as OpenGL and Vulkan, and the GLSL programming language. They will also become acquainted with the basic mathematical and physical notions and algorithms that generate various effects, e.g., realistic lighting, environment mapping, bump mapping. During the course, the students will prepare projects in teams of maximum two and present their work results in front of the group.

Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Project	The students prepare the project and present the chosen topic connected with real-time graphics.	M_001, M_002, M_003, M_004, M_005, M_006, M_007, M_008
W_002	Reports	The students solve sets of tasks.	M_001, M_002, M_003, M_004, M_006

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures have a form of presentation with the use of audiovisual methods.	15	The students self-study the lecture topics and recommended literature.	15	W_001
Z_002	laboratory classes	The classes thoroughly prepare the students to (1) creating applications displaying complex computer graphics in real-time, (2) development of suitable algorithms. The students solve programming tasks.	30	The students get acquainted with the subject of the laboratory classes and the chosen project, prepare it in a team and present it in front of the group.	60	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Recommendation systems and social networks

Module code: W4-INA-S2-20-F-SRiSS

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the use and implementation of algorithms used in recommendation systems.	K_W01 K_W02 K_W04	1 1 1
M_002	The student knows the operation of recommendation systems and social networks.	K_W02 K_W05 K_W07	1 1 1
M_003	The student can choose and implement the algorithm used in recommendation systems.	K_U01 K_U08 K_U09	1 1 1
M_004	The student can develop a scheme of dealing with data in recommendation systems, aimed at the proper operation of such a system.	K_U03 K_U04 K_U06 K_U09	1 1 1 1
M_005	The student is aware of raising their competences through continuous self-improvement.	K_K01 K_K02	1 1

3. Module description

Description	The module’s aim is to acquaint the students with recommendation systems, their operating principles and algorithms associated with them, and with social networks and methods of their analysis.
Prerequisites	

4. Assessment of the learning outcomes of the module			
code	**type**	**description**	**learning outcomes of the module**
W_001	Reports	The students prepare written reports within a specified period as verification of skills gained during problem-solving.	M_001, M_002, M_003, M_004, M_005
W_002	Final test	The test checks knowledge on the topics covered in the lectures.	M_001, M_002, M_005

5. Forms of teaching						
code	**form of teaching**			**required hours of student's own work**		**assessment of the learning outcomes of the module**
	type	**description (including teaching methods)**	**number of hours**	**description**	**number of hours**	
Z_001	lecture	The lectures are conducted with multimedia tools and discuss issues related to recommendation systems and social networks.	15	The students prepare for laboratory classes and passing the lecture test.	20	W_002
Z_002	laboratory classes	The classes prepare the students to perform laboratory tasks. They are the practical implementation of issues discussed during lectures.	30	The students prepare for laboratory tasks and solve them individually.	55	W_001

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Scripting languages in data analysis

Module code: W4-INA-S2-20-F-JSwAD

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the use and implementation of algorithms.	K_W02 K_W09	1 1
M_002	The student knows how to analyse data, is familiar with the algorithms used in data analysis, and knows how to interpret the results.	K_W04 K_W09	1 1
M_003	The student can select and implement the algorithm for data analysis.	K_U08 K_U09 K_U10	1 1 1
M_004	The student can interpret the result of data analysis and present the results of data analysis motivate the techniques used.	K_U03 K_U04 K_U10	2 2 1
M_005	The student can develop a scheme of data handling, aimed at their correct analysis.	K_U01 K_U02 K_U03	1 1 1
M_006	The student can implement an automated data analysis system, working individually or in a team.	K_U02 K_U09 K_U10	1 2 3
M_007	The student is aware of the impact of algorithms on the results of data analysis.	K_K01	1

3. Module description	
Description	The module aims at introducing the students with advanced data analysis possibilities with elements of automation using scripting languages such as Python or R.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Reports	The students prepare written reports within a specified period as verification of skills gained during problem-solving.	M_001, M_002, M_003, M_004, M_007
W_002	Project	The students develop an individual or group project with documentation of the data analysis system.	M_001, M_002, M_003, M_005, M_006, M_007

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are conducted with multimedia tools and discuss issues related to the analysis and automation of data analysis in scripting languages.	15	The lectures prepare the students to perform laboratory exercises. They are the practical presentation of issues discussed during the lectures.	20	W_002
Z_002	laboratory classes	The classes prepare the students to perform laboratory exercises. They are the practical presentation of issues discussed during the lectures.	30	The students prepare for the laboratory classes and passing the lecture test. The students prepare for completing laboratory tasks and the final project	55	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Selected graph algorithms

Module code: W4-INA-S2-20-F-WAG

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student is familiar with the concept of graphs, including trees, along with their features and types.	K_W01 K_W04 K_W09	1 1 1
M_002	The student understands the functioning of graph algorithms and trees used to solve selected practical problems.	K_W02 K_W04 K_W09	1 1 1
M_003	The student can apply an appropriate algorithm to solve a problem.	K_U01 K_U08	1 1
M_004	The student can construct a solution to a problem according to a specific algorithm and program it in the chosen programming language.	K_U01 K_U02 K_U03	1 1 1
M_005	The student can work in a project-programming team.	K_K01 K_K03 K_K05	1 1 1
M_006	The student knows how to implement graphs, including trees, using tables and pointers.	K_W01 K_W09	1 1
M_007	The student can implement graphs and trees using data structures available in particular programming languages.	K_U01 K_U03 K_U04	1 1 1

		K_U09	1

3. Module description	
Description	The course aims at acquainting the students with the basic knowledge of graph theory and selected graph algorithms. The students solve practical problems such as for which graph it is possible to apply representation, which can be solved using appropriate graph algorithms.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Evaluation of presentation and computer implementation	The students develop their own software, the specification of which is given by the teacher, and make presentations on a chosen topic from the given list.	M_001, M_002, M_003, M_004, M_005, M_006, M_007
W_002	Evaluation work	The evaluation has a form of a written mid-term test (including a test performed on a computer during classes).	M_001, M_002, M_003, M_006, M_007
W_003	End-term test	The students answer test questions and describe problems by answering open-ended questions.	M_001, M_002, M_003, M_004, M_006, M_007

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have a verbal form with the use of content visualisation. They primarily focus on conceptually demanding material, address some external sources and illustrate the content with some examples.	15	The students study the lecture's topic using the existing packages of methods: manuals, scripts, websites, etc.	30	W_003
Z_002	laboratory classes	The classes thoroughly train the students to solve tasks concerning the proceeding method and the sequence of operations. The students design solutions and their computer implementation and present them in front of the class.	30	The students complete tasks from particular topics and analyse existing solutions, available in the recommended materials and websites, and prepare for discussions or catching up.	45	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Statistical analysis in research

Module code: W4-INA-S2-20-1-ASwPB

1. Number of the ECTS credits: 2

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows the average measures of variability, dispersion, asymmetry, correlation analysis and can use them.	K_U03 K_U08 K_W01 K_W09	1 1 1 1
M_002	The student knows various methods of graphic presentation of qualitative and quantitative data. They can choose the graph for the data and create it.	K_U01 K_W09	1 1
M_003	The student knows statistical inference. They can use selected statistical tests to confirm the significance of the hypotheses. They can choose the right test, depending on a hypothesis and data.	K_U01 K_U03 K_U09 K_W01 K_W09	1 1 1 1 1
M_004	They can use the selected program to perform statistical analysis and to confirm the hypotheses. Based on the obtained experimental results, they can conclude and show their statistical significance.	K_K04 K_U01 K_U03 K_U07	1 1 1 1

3. Module description

Description	The module's purpose is to present the basics of data analysis, including descriptive statistics, graphic methods for the presentation of qualitative and quantitative data, and statistical inference elements. Content:

	The module's purpose is to present the basics of data analysis, including descriptive statistics, graphic methods for the presentation of qualitative and quantitative data, and statistical inference elements. Content: 1. Descriptive statistics: average measures, measures of variability, dispersion, asymmetry, correlation analysis. 2. Graphic methods for presenting qualitative and quantitative data: histogram, frequency diagram, scatter plot, box plot. 3. Elements of statistical inference: concepts of the null and alternative hypothesis, significance level and p-value. Selection of test depending on the hypothesis and the data: Student's t-test, Wilcoxon test, Friedman test, Kruskal-Wallis test, Fisher test, chi-square test.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The test verifies knowledge and skills based on completed tasks.	M_001, M_002, M_003
W_002	Examination reports	The students prepare written reports and their oral presentation at a specified time as verification of gained skills during problem-solving.	M_001, M_002, M_003, M_004

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures present concepts and facts from the programme contents listed in the module and illustrate them with many examples.	15	The students self-study the lectures and recommended literature.	15	W_001
Z_002	laboratory classes	During the laboratory classes, the students complete tasks with the teacher's help, which develops the skills listed in the set of learning outcomes of the module.	15	The students improve the skills listed in the set of learning outcomes of the module.	15	W_001, W_002

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2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Techniques for optimizing computer programs

Module code: W4-INA-S2-20-F-TOPK

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student knows how computations are made in modern computers and how they affect the overall computation time.	K_K01 K_U05 K_U09 K_W02	1 1 1 1
M_002	The student knows programming techniques and tools, allowing better use of modern computers' computing power.	K_U01 K_U09 K_W02 K_W03 K_W04	1 1 1 1 1
M_003	The student can use tools that facilitate diagnostics of performance-related problems in computer programmes.	K_U01 K_U05 K_W02 K_W03	1 1 1 1
M_004	The student can choose algorithms and data structures to improve the efficiency of computations.	K_U05 K_U09 K_W02 K_W04	1 1 1 1

3. Module description

Description	

	The module aims at acquainting the students with optimising the computer programmes' performance, discussing both programming tools and algorithmic solutions and considering modern computers' architecture.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Final test.	The test checks the knowledge gained during lectures and laboratory classes. It comprises some closed and (optionally) open-ended questions.	M_001, M_002, M_004
W_002	Midterm test.	At least one test midterm test assesses the knowledge gained by the students during laboratory classes.	M_001, M_002, M_003, M_004
W_003	Programming assignment.	Optional programming assignments verify the skills gained during the course.	M_001, M_002, M_003, M_004

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The course material has verbal and written forms, supplemented with multimedia content, emphasising issues which are most challenging and deeply grounded in theory. The students are encouraged by asking questions about the presented content.	15	The students read the recommended books and articles, analyse and repeat the lecture content and prepare for the final test.	30	W_001, W_002, W_003
Z_002	laboratory classes	The classes prepare the students to apply the programming practice knowledge by presenting sample programmes and programming tools, discussing the methods and sequence of operations in detection, analysis and resolution of performance problems in computer programmes.	30	The students work on assignments and study the recommended literature.	45	W_002, W_003

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2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: The concept of programming languages

Module code: W4-INA-S2-20-F-KJP

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student is familiar with the programming paradigms: procedural programming, object-oriented programming, structured programming, concurrent programming, imperative, functional and logic programming and their relation to the computer architecture (including parallel and multiprocessor programming).	K_W02 K_W04	1 1
M_002	The student understands basic programming constructions and knows the data types of imperative languages and programming constructions characteristic for logical and functional approaches	K_W04 K_W05	1 1
M_003	The student has knowledge concerning the implementation of mechanisms characteristic for a particular programming paradigm in specific programming languages.	K_W02 K_W04 K_W08 K_W09	1 1 1 1
M_004	The student can solve a problem according to a specific programming paradigm and program it in the chosen programming language.	K_U01 K_U02 K_U03	1 1 1
M_005	The student can apply object-oriented, structured, functional and declarative approaches in specific programming languages.	K_U01 K_U02 K_U03	1 1 1
M_006	The student can verify a computer program's reliability employing testing in the programming environment and document the program.	K_U01 K_U02 K_U04 K_U09	1 1 1 1
M_007	The student can work in a programming project team.	K_K01	1

		K_K03 K_K05	1 1

3. Module description	
Description	The course aims at giving the students the knowledge of the principles of designing and implementing computer programmes in selected languages representing an imperative, functional and declarative approach. The students develop their knowledge and skills in applying various programming paradigms, learning the programming languages characteristic for these paradigms.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Evaluation of presentation and computer implementation	The teacher gives a specification of software later developed by the students who also perform presentations on a chosen topic from the list.	M_001, M_002, M_003, M_004, M_006, M_007
W_002	Mid-term test	There is a written mid-term test (including a test performed on a computer during classes).	M_001, M_002, M_003, M_005
W_003	End-term test	The students answer closed-ended test questions and describe problems in open-ended questions.	M_001, M_002, M_003, M_004, M_005, M_006

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have a verbal form using content visualisation, focusing on conceptually challenging material, referring to the external sources, and illustrating the content with some examples.	15	The students prepare for the lectures using the existing methods: manuals, scripts, websites, etc.	30	W_003
Z_002	laboratory classes	The classes thoroughly prepare the students to complete tasks concerning the methods and the sequence of operations, design solutions, and computer implementations presented by the students in front of the group.	30	The students complete tasks from particular topics and analyse solutions existing in materials and websites and prepare their solutions for discussion or study to catch up.	45	W_001, W_002

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Web applications

Module code: W4-INA-S2-20-F-AI

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student can characterise applications in the client-server architecture, particularly Internet ones, lists the essential elements of the multi-layer structure of this type of application.	K_W03 K_W05	1 1
M_002	The student can define the concept of network application and application server and characterise the application requirements for implementation on servers based on various technologies.	K_W03 K_W06	1 1
M_003	The student can distinguish and describe elements of internet technologies on the selected platform.	K_W05 K_W06	1 1
M_004	The student can characterise the rules of connecting and using relational database servers in Internet technologies.	K_W06 K_W09	1 1
M_005	The student can describe the MVC structure (Model-Viewer-Controller) application, especially in creating database web applications.	K_W05	1
M_006	The student can use programming environments to create internet projects, create applications divided into packages/modules, and apply appropriate comments.	K_U01 K_U03 K_U09	1 1 1
M_007	The student can create controllers, i.e. request handling objects and handle requests based on the GET and POST methods. They can also install network applications on the application server and configure it in the basic scope.	K_U01 K_U02 K_U08 K_U09 K_U10	1 1 1 1 1
M_008	The student can create web applications based on the selected technology, use component libraries and cookie and session mechanisms.	K_K01	1

		K_K02 K_U01 K_U02 K_U09 K_U10	1 1 1 1 1
M_009	The student can use libraries/modules for communication with the database to implement the data layer, design and manage the connection to the database from the application itself, and the application server.	K_U01 K_U09 K_U10	1 1 1
M_010	The student can use the MVC (Model-View-Controller) model in database projects created in the selected technology.	K_U09 K_U10	1 1
M_011	The student can work independently, planning the implementation of assigned tasks.	K_K01	1

3. Module description	
Description	The class aims at providing operational basics in web applications development in the chosen technology (PHP, Java, ASP .NET, Ruby, Python or other). Through practical laboratory class and project development, the students gain knowledge, skills and competences related to the subject. The students can design a web application using a database, implement it, and deploy on a web server on completing the course
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Test	The test comprises several questions selected from the thematic groups covering all the sections discussed in the classes.	M_001, M_002, M_003, M_004, M_005
W_002	Subject tasks	The students should complete subject tasks during the laboratory classes.	M_006, M_007, M_008, M_009, M_010, M_011
W_003	Project	The students should complete their projects.	M_006, M_007, M_008, M_009, M_010, M_011

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures have a verbal form with the support of multimedia and other materials available on the Internet.	15	The students study lecture topics based on available materials.	25	W_001
Z_002	laboratory classes	The laboratory classes introduce to practical aspects of the module domain. The students	30	The students solve practical tasks given by the teacher and implement the assigned	50	W_002, W_003

		discuss the problems with the teacher who support them in the task completion, discuss the project topics and help them in the implementation.		project using the provided documentation and laboratory examples.		

1.	**Field of study**	**Computer Science**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (summer term)
4.	Level of qualifications/degree	second degree studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Wireless and sensor networks

Module code: W4-INA-S2-20-F-SBiS

1. Number of the ECTS credits: 4

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
M_001	The student has skills for wireless network design.	K_U03 K_U04 K_W03	1 1 1
M_002	The student knows ad hoc and sensor network architecture and communication protocols.	K_W03 K_W05	1 1
M_003	The student can implement the concepts in real-world wireless network applications.	K_K01 K_U08 K_W02	1 1 1

3. Module description

Description	The module aim is to give students a knowledge of the ad hoc and sensor networks based on wireless technology, with particular attention on their construction and applications. The presented topics are related to wireless networks components, energy-efficient standards of data transmission, routing protocols, dedicated operating systems, programming languages, and principles of adopting the network node architecture to specific requirements. Students will gain the abilities to design and configure wireless networks.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
W_001	Final test	The two-hour test comprises closed and open-ended questions.	M_001, M_002

W_002	Reports	The students present the reports and discuss the developed projects.	M_001, M_003

5. Forms of teaching

code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
Z_001	lecture	The lectures are supported by multimedia presentations and e-learning support.	15	The students self-study the literature and materials presented during lectures.	25	W_001
Z_002	laboratory classes	During the classes, the students complete the assignments like design projects using network devices and simulators.	30	The students complete project assignments and prepare presentations.	50	W_002