UNIVERSITY OF INFORMATION SCIENCES AND TECHNOLOGIES
"SAINT PAUL THE APOSTLE" OHRID

FACULTY OF COMPUTER SCIENCE AND ENGINEERING



Computer Techniques and Informatics

Third cycle of studies

Basic information about the study program

1	Name of the study program	Computer Techniques and Informatics
2	University unit	Faculty of Computer Science and Engineering
3	Type of studies	Third cycle of university, academic studies
4	Degree or level of qualification acquired by completing studies according to the NQF	VIII
5	Years and semesters of duration of the study program	3 years, 6 semesters
6	ECTS credits acquired by the student	180 ECTS
7	The academic title that the student acquires after completing the study program	Doctor of computer technology and informatics
8	The scientific title in English that the student receives upon completion of the study program	Ph.D. in Computer Technics and Informatics
9	Language in which instruction will be conducted	English and Macedonian language

STUDY PROGRAM

semester	Serial number or code	Subject/activity name	Number of ECTS credits		Affiliation to a subject/activity according to the Higher Education Act
			Mandatory subjects/activities	Elective courses	
FIRST SEMESTER	CTI 3 1M1	Scientific research methods and skills for writing papers and projects	6		Academic training
	CTI 3 1M2	Scientific research methodology work in computer technology and informatics	6		Academic training
	CTI 3 xExx	Elective subject		7.5	Academic training
	CTI 3 xExx	Elective subject		7.5	Academic training
SECOND SEMESTER	CTI3xExx	Elective subject		7.5	Academic training
	CTI3xExx	Elective subject		7.5	Academic training
		Doctoral seminar with presentation	2		Lectures and other types of communication activities
		Independent research for the preparation of a doctoral thesis topic dissertation	14		Independent research project under mentorship
		Annual conference with presentation	2		Lectures and other types of communication activities
THIRD semester		Submitting a proposal project for the production of doctoral thesis	26		Independent research project under mentorship
		Doctoral seminar with presentation	4		Lectures and other types of communication activities
FOURTH semester		Research workshop	3		Lectures and other types of communication activities
		Writing a doctoral thesis	25		Preparation and public defense of the doctoral thesis based on the doctoral project
		Annual conference with presentation	2		Lectures and other types of

					communication activities
FIFTH semester		Independent research and publication of results	26		Publication in reference scientific publications and active participation in international meetings related to the doctoral thesis
		Doctoral seminar with presentation	4		Lectures and other types of communication activities
SIXTH semester		Research workshop	3		Lectures and other types of communication activities
		Defense of the doctoral thesis	2 7		Preparation and public defense of the doctoral thesis based on the doctoral project
		Total	150	30	

Within this study program, 2-5 elective courses are defined from the unit where the study program is implemented, in the List of Elective Courses of the study program. From this list of elective courses, students can choose 2 (two) courses in the winter first semester and 2 (two) courses in the summer second semester, for which they receive a total of 30 credits.

Additional conditions and propositions for the selection of professional subjects are regulated in the Regulation on conditions and propositions for studying in the third cycle of studies at UINT "St. Apostle Paul" - Ohrid .

Table : Elective and teaching subjects of the study program

It 's a num ber.	Code	Subject name	Seven years old	ECTS
1.	CTI 3 xE 01	Advanced algorithms and data structures	winter/summer	7, 5
2.	CTI 3 xE 02	Advanced distributed systems	winter/summer	7, 5
3.	CTI 3 xE 03	Modern concepts of cybersecurity and advanced cryptography	winter/summer	7, 5
4.	CTI 3 xE 04	Advanced digital forensics	winter/summer	7, 5
5.	CTI 3 xE 05	Advanced computer architectures	winter/summer	7, 5
6.	CTI 3 xE 06	Modern methods for parallel processing	winter/summer	7, 5
7.	CTI3xE0 7	Advanced parallel programming	winter/summer	7.5
8.	CTI3xE0 8	Semantic Web	winter/summer	7, 5

9.	CTI3xE0 9	Big data management and analysis	winter/summer	7, 5
10.	CTI3xE 10	Advanced database theory and application	winter/summer	7, 5
11.	CTI3xE 11	Expert systems and multimedia	winter/summer	7, 5
12.	CTI3xE 12	Generative artificial intelligence	winter/summer	7, 5
13.	CTI3xE 13	Holography and mixed reality	winter/summer	7, 5
14.	CTI3xE 14	Advanced multimedia information systems	winter/summer	7, 5
15.	CTI3xE 15	Advanced aspects of social networks	winter/summer	7, 5
16.	CTI3xE 16	Modern techniques in the cloud	winter/summer	7, 5
17.	CTI3xE 17	Advanced decision theories	winter/summer	7, 5
18.	CTI3xE 18	Optimization modeling	winter/summer	7, 5
19.	CTI3xE 19	Statistical data analytics	winter/summer	7, 5
20.	CTI3xE 20	Advanced methods for computer network security	winter/summer	7, 5
21.	CTI3xE 21	Stochastic models in information and communication technologies	winter/summer	7, 5
22.	CTI3xE 22	Advanced optimization methods	winter/summer	7, 5
23.	CTI3xE 23	Advanced information theory and coding	winter/summer	7, 5
24.	CTI3xE 24	Advanced e-government models	winter/summer	7, 5
25.	CTI3xE 2 5	E-business technologies	winter/summer	7, 5

List of accredited mentors in accordance with Article 1 36 paragraph 8 of the Law on Higher Education ("Official Gazette of the Republic of Macedonia", No. 82/2018)

Serial No.	Teacher	Teaching and scientific title
1	Prof. Dr. Ninoslav Marina	Full professor
2	Prof. Dr. Elena Hadzieva	Full professor
3	Prof. Dr. Atanas Hristov	Associate Professor
4	Prof. Dr. Aneta Velkoska	Associate Professor
5	Prof. Dr. Diana Capeska Bogatinoska	Associate Professor
6	Prof. Dr. Anis Sefidanoski	Associate Professor
7	Prof. Dr. Aleksandar Karadimche	Associate Professor

Attachment No. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Advanced Aspects of Social Networks			
2.	Code	CTI3xE 15			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Associate prof. Aneta Velkoska			
9.	Prerequisites for attending the course	/			
10.	**Course Objectives (Competencies):** Complex networks represent a wide range of natural and social systems. While these systems were traditionally modelled as random graphs, it has become increasingly evident that the topology and evolution of real-world networks are governed by specific organisational principles of large-scale networks. This course is designed to introduce students to the latest aspects of complex networks, focusing on the statistical mechanisms underlying the structure and dynamics of complex networks.				
11.	**Course Content:** • Basic concepts: Undirected and directed networks, weighted networks, bipartite networks; nodes, links, and their general characteristics • Matrix representation • Graph theory: vertices and edges • Connectivity, clustering coefficient, neighborhood • Centrality measures such as degree centrality, closeness centrality, betweenness centrality, and PageRank • Search algorithms: Depth-First Search (DFS), Breadth-First Search (BFS), shortest path problem • Partitions, cluster detection, and community detection • Examples of special random graph models: Erdos–Renyi, Barabasi–Albert, Watts–Strogatz • Hubs, preferential attachment, cumulative advantage, and “small-world” networks • Graph representations: adjacency matrices, weighted matrices, and edge lists • Additional matrix characteristics: degree matrix and Laplacian matrix • Graph operations: subgraphs or graph reduction, concatenation, hybrid links • Performance of graph algorithms on large-scale networks • Various tools for graph analysis.				
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, practical exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and presentation of project assignments and seminar papers, and learning in an electronic environment (forums and consultations).				
13.	Total available fund on time	120 hours			

14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours		
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours
16.	Other forms of activities	16.1.	Project tasks	30 hours
		16.2.	Independent tasks	15 hours
		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points
	17.3.	Activity and Participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)
			51 x to 60 points	6 (six) (E)
			61 x to 70 points	7 (seven) (D)
			from 71 to 80 points	8 (eight) (C)
			from 81 to 90 points	9 (nine) (B)
			from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction		Macedonian and English	
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods	

22. Literature

22.1. Required literature

Ord. Number	Author	Title	Publisher	Year
1.	Carrington, PJ, Scott, J., Wasserman S.	Models and Methods in Social Network Analysis	Cambridge University Press	2005
2.				
3.				

22.2. Additional literature

Ord. Number	Author	Title	Publisher	Year

		1.	Albert, R., Barabasi, AL	Statistical Mechanics of Complex Networks	Reviews of Modern Physic s 74, 47 - 9 7	2002
		2.	Barabasi, AL, Albert, R	Emergence of Scaling in Random Networks	Science, 286, 509 - 512	1999
		3.				

Annex no. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Advanced database theory and application			
2.	Code	CTI3xE 10			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Assoc. Prof. Dr. Dijana Capeska Bogatinoska			
9.	Prerequisites for enrolling in the course	/			
10.	Objectives of the subject program (competencies) : After completing this module, candidates will be able to provide : • Critical review of new developments in database technology. • Interpreting and explaining the impact of new database standards. • Evaluation of the contribution of database theory to the practical implementation of database management systems.				
11.	Content of the subject program: / (Përbajtja e programitem ħedor) 1. Relational theory and concepts 1.1. Basic theoretical concepts (Fundamentals of relational systems) 1.2. Description of the relational model (Conformity and integrity; Use of constraints ; Approaches to designing mappings of relational systems) 2. Processing data from the database 2.1. Description of advanced SQL programming (Using SQL to query and manipulate data and data objects) 2.2. Query transformation ; Optimization approaches ; Use of constraints ; Creating and using different types of indexes) 2.3. Concurrency control and transaction management (ACID principle; Two-phase locking and deadlocks; Recovery and transaction design) 2.4. Database Performance Tuning (Maximizing Storage and Memory Usage; Memory Components and Caching Techniques) 2.5. Distributed Relational Systems (Data Replication: Synchronous and Asynchronous; The Two-Phase Commit Protocol and its Weaknesses; Implications for Cloud Storage) 3. Post-relational systems 3.1. Use of object-oriented systems (Object-oriented database management systems; Deductive database management systems; Spatial database management systems; Temporal database management systems; Constrained database management systems) 3.2. New Database Management Systems (Data Warehouses; Multimedia; Mobility; NoSQL; Native XML Databases (NXD); Document - oriented Databases ; Statistical Databases) 4. Using standards				

	4.1. Explaining SQL standards in relation to application development (Use of SQL and industry standards; Limitations of standardization) 4.2. Description of interoperability and integration standards (e.g. Web services; JSON) 5. Database security 5.1. Analyzes database security methods and techniques (Data Encryption; Redaction and Masking Techniques; Authentication and Authorization; Database Auditing)				
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).				
13.	Total Available Fund at Time	120 hours			
14.	Distribution of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of evaluation				
	17.1.	Final Exam		40 points	
	17.2.	Seminar paper/project, written and oral presentation		50 points	
	17.3.	Activity and Participation		10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)	
			51 x to 60 points	6 (six) (E)	
			61 x to 70 points	7 (seven) (D)	
			from 71 to 80 points	8 (eight) (C)	
			from 81 to 90 points	9 (nine) (B)	
			from 91 to 100 points	10 (ten) (A)	
19.	Requirement for signature and passing the final exam	Attendance at the Activities 15.1 and 15.2			
20.	Language of instruction	Macedonian and English			
21.	Method of monitoring the quality of teaching	In accordance with the university procedures and quality control methods			
22.	Literature				
	22.1.	Mandatory literature			
			Author	Title	Publisher	Year

		1.	CJ Date	An Introduction to Database Systems (eighth edition)	Addison-Wesley Longman	2003
		2.	A. Silberschatz, H. Korth and S. Sudarshan	Database System Concepts (sixth edition)	McGraw-Hill	2010
		3.	W. Lemahieu, S. vanden Broucke and B. Baesens	Principles of Database Management: Practical Guide to Storing, Managing and Analyzing Big and Small Data	Cambridge University Press	2018
		4.	TM Connolly and C. Begg	Database Systems: Practical approach to design, implementation, and management (sixth edition)	Pearson Education	2015
	22.2.	Additional literature				
		Order No. / Nr.rend.	Author / Authors	Title / Title	Publisher / Boteusi	Year / Viti
		1.	J. Melton and A. Simon	SQL 1999: Understanding Relational Language Components	Morgan-Kaufmann	2003
		2.	P. Adams	The Ultimate Guide from Beginner to Expert - Learn and Master SQL in No Time	Addison Wesley	2016
		3.	M. Kleppmann	Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems	O'Reilly	2017

Attachment No. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Advanced Decision-Making Methods			
2.	Code	CTI3xE17			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Associate prof. Aneta Velkoska			
9.	Prerequisites for enrolling in the course	/			
10.	**Course Objectives (Competencies):** This course is designed to introduce and train students in a wide range of problems they are likely to encounter in their workplace. Some of the quantitative methods and concepts are quite advanced and may seem intimidating at first. It is important to note that no one fully understands the entire scope of every method or technique for making inferences. Regardless of students' prior knowledge, the focus of this course is to build upon existing knowledge by tracking and comparing individual progress. The main goal of this course is to eliminate any doubts students may have (if any) regarding data analysis, to enhance their analytical tools for analysis and synthesis, and to develop a broad analytical intuition.				
11.	**Course Content:** Fundamentals of database modelling and design; how to access, integrate, organize, prepare, and transform data for analysis; and introduction to concepts, methods, and processes of business analytics for creating competitive advantage. Statistical methods for data analysis, descriptive and inferential techniques and methods, and regression modelling.				
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, practical exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and presentation of project assignments and seminar papers, and learning in an electronic environment (forums and consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	

		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points
	17.3.	Activity and Participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)
			51 x to 60 points	6 (six) (E)
			61 x to 70 points	7 (seven) (D)
			from 71 to 80 points	8 (eight) (C)
			from 81 to 90 points	9 (nine) (B)
			from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction		Macedonian and English	
21.	Method of monitoring the quality of teaching		Monitoring UINT control procedures	

22. Literature

22.1. Required literature

Ord. Number	Author	Title	Publisher	Year
1.	A. Sahay	Business Analytics, Volume I: A Data-Driven Decision Making Approach for Business	Business Expert Press	20 15
2.				
3.				

22.2. Additional literature

Ord. Number	Author	Title	Publisher	Year
1.				
2.				
3.				

<table>
<tr><td colspan="2">Attachment No. 3</td><td colspan="4">Course program of the third cycle of studies</td></tr>
<tr><td>1.</td><td>Title of the course</td><td colspan="4">Advanced Digital Forensics</td></tr>
<tr><td>2.</td><td>Code</td><td colspan="4">CTI3xE0 4</td></tr>
<tr><td>3.</td><td>Study program</td><td colspan="4">Computer techniques and informatics</td></tr>
<tr><td>4.</td><td>Organizer of the study program (unit, i.e. institute, department, division)</td><td colspan="4">UIST, Faculty of computer sciences and engineering</td></tr>
<tr><td>5.</td><td>Degree (first, second, third cycle)</td><td colspan="4">Third cycle</td></tr>
<tr><td>6.</td><td>Academic year / semester /</td><td>First year / winter/summer</td><td>7.</td><td>Number of ECTS credits</td><td>7.5</td></tr>
<tr><td>8.</td><td>Teacher</td><td colspan="4">Full Professor Dr. Ustiana Rechkoska Shikoska</td></tr>
<tr><td>9.</td><td>Prerequisites for attending the course</td><td colspan="4">/</td></tr>
<tr><td>10.</td><td colspan="5">Course objectives (competencies): This course focuses on advanced topics in the analysis of modern operating systems, including advanced data system analysis, network security, and the analysis and implementation of a comprehensive forensics process in cyberspace.</td></tr>
<tr><td>11.</td><td colspan="5">Course content:
• Research process; Analysis methodologies; Tools and techniques
• Setting up the investigative software
• history and background ; Allocation tables; Directory entries; Bitmaps; Deleted files and unallocated space
• FAT analysis
• History and Background ; Master File Table (MFT); MFT Entries; Deleted Entries; Unallocated Space
• NTFS analysis
• Popular file sharing protocols and applications; File sharing logs; Network logs; Advanced BitTorrent analysis
• Static analysis; Dynamic analysis; Virtualization
• Live Systems Analysis; Volatile Data Collection
• Dumping physical memory; Analyzing physical memory
• The Role of Digital Forensics in Law Enforcement; Guest Speaker from Various Agencies</td></tr>
<tr><td>12.</td><td colspan="5">Teaching methods:
Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).</td></tr>
<tr><td>13.</td><td>Total Available Fund at Time</td><td colspan="4">120 hours</td></tr>
<tr><td>14.</td><td>Allocation to available time</td><td colspan="4">45 + 5 + 30 + 15 + 25 = 120 hours</td></tr>
<tr><td rowspan="2">15.</td><td rowspan="2">Forms of teaching activities</td><td>15.1.</td><td colspan="2">Lectures - theoretical teaching .</td><td>45 hours</td></tr>
<tr><td>15.2.</td><td colspan="2">Exercises (laboratory, classroom), seminars, teamwork.</td><td>5 hours</td></tr>
</table>

16.	Other forms of activity	16.1.	Project tasks	30 hours
		16.2.	Independent tasks	15 hours
		16.3.	Homework – assignments	25 hours

17.	Method of assessment		
	17.1.	Final Exam	40 points
	17.2.	Seminar paper/project, written and oral presentation	50 points
	17.3.	Activity and Participation	10 points

18.	Assessment criteria (points/grade)	up to 50 points	5 (five) (F)
		51 x to 60 points	6 (six) (E)
		61 x to 70 points	7 (seven) (D)
		from 71 to 80 points	8 (eight) (C)
		from 81 to 90 points	9 (nine) (B)
		from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam	Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction	Macedonian and English	
21.	Method of monitoring the quality of teaching	In accordance with the university procedures and quality control methods	

22.	Literature					
	22.1.	Compulsory literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	A. Harisha Amarnath Mishra, PhD Chandra Singh	Advances in Cybercrime Investigation and Digital Forensics	Apple Academic Press	2023
		2.				
		3.				
	22.2.	literature				
		Order No.	Author	Title	Publisher	Year
		1.				
		2.				
		3.				

Attachment No. 3		**Course program of the third cycle of studies**			
1.	Subject title	Advanced distributed systems			
2.	Code	CTI3xE02			
3.	Study programs	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Full Professor Dr. Ustiana Rechkoska Shikoska			
9.	Prerequisites for enrolling in the course	/			
10.	**Objectives of the course program (competences):** The student will acquire knowledge about Advanced Distributed Systems, Advanced Architectures of Distributed Systems; Modern Processes, Communications; Naming, Synchronization; Distributed Databases - DBP, Advanced Distributed Databases ; Advanced Distributed Database Management System, design, object databases, languages and software tools, transaction management and hybrid databases, Security of Advanced Distributed Systems.				
11.	**Course content**: Object-oriented and service-oriented distributed systems; Objects, connectivity and databases. Distributed databases, redundancy, normalization, functional dependency. Data distribution. Types of distributed databases - DBP. Distributed DBP. Levels of work with DBP. Updating the database from multiple locations. Distributed information systems. Advanced Distributed transaction programs of the information system by locations. Threats in advanced distributed systems. Features and use of the UML language. Logic and design of DBP. Object databases. Object-oriented database languages. Architecture and model of object databases. Operations on object databases. Deductive databases. Hybrid databases. Distributed algorithms. Data analysis and mining, OLAP. Transact-SQL features in MS SQL Server, scalar and table functions, stored procedures, switches. Databases with management systems. LINQ to Entity Framework. Decentralized algorithms; Distributed systems security; Authentication; Access control; DoS; Secure mobile code; Authorization management.				
12.	**Teaching methods**: Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .		45 hours

		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours
16.	Other forms of activities	16.1.	Project tasks / Project tasks	30 hours
		16.2.	Independent tasks / Independent task	15 hours
		16.3.	Home study - assignments / Learning by doing - homework	25 hours

17.	Method of assessment / Method of assessment		
	17.1.	Final exam	40 points
	17.2.	Individual work/project (presentation: written and oral	50 points
	17.3.	Activity and participation	10 points

18.	Evaluation criteria (points/grade)	up to 50 points	5 (five) (F)
		51 x to 60 points	6 (six) (E)
		61 x to 70 points	7 (seven) (D)
		from 71 to 80 points	8 (eight) (C)
		from 81 to 90 points	9 (nine) (B)
		from 91 to 100 points	10 (ten) (A)

19.	Requirement for signing and passing the completed exam	Attendance at the Activities 15.1 and 15.2
20.	Language in which classes are conducted	Macedonian and English
21.	Method for monitoring the quality of teaching	In accordance with the university procedures and quality control methods

22.	Literature					
	22.1.	Compulsory literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	Maarten van Steen, Andrew S. Tanenbaum	Distributed Systems, Third Edition, Version 3.01. 2017	CreateSpace Independent Publishing Platform	2017

		2.	Garcia-Molina H., Ullman J. D., Widom., J.	Database Systems: The Complete Book	Prentice Hall	2009
		3.	Ben-gan, I	Microsoft SQL Server 2008 T-SQL Fundamentals	Microsoft Press	2008
		4.	Calvert, C.; Kulkarni, D.	Essential LINQ	Addison-Wesley	2009
	22.2.	literature				
		Order No.	Author	Title	Publisher	Year
		1.	Satinder Bal Gupta, Aditya Mittal	Introduction to Database Management Systems" Second Edition	Typeset at Sukuvisa Enterprises, Delhi	2017

<table>
<tr><td colspan="2">Annex no. 3 / Shtojca nr. 3</td><td colspan="5">Course program of the third cycle of studies /</td></tr>
<tr><td>1.</td><td>Title of the course</td><td colspan="5">Advanced e-government models</td></tr>
<tr><td>2.</td><td>Code</td><td colspan="5">CTI3xE24</td></tr>
<tr><td>3.</td><td>Study program</td><td colspan="5">Computer Techniques and Informatics</td></tr>
<tr><td>4.</td><td>Organizer of the study program (unit, i.e. institute, department, division)</td><td colspan="5">UIST, Faculty of computer sciences and engineering</td></tr>
<tr><td>5.</td><td>Degree (first, second, third cycle)</td><td colspan="5">Third cycle</td></tr>
<tr><td>6.</td><td>Academic year / semester /</td><td>First year / winter / summer</td><td>7.</td><td>Number of ECTS credits</td><td colspan="2">7.5</td></tr>
<tr><td>8.</td><td>Teacher</td><td colspan="5">Prof. Dr. Ivan Bimbilovski</td></tr>
<tr><td>9.</td><td>Prerequisites for attending the course</td><td colspan="5">/</td></tr>
<tr><td>10.</td><td colspan="6">Course objectives (competencies): The aim of the course is for students to analyze the delivery of services by government institutions to users: citizens, businesses and organizations.
from the non-governmental sector and the application of information technologies in them processes; to analyze advanced countries and advanced areas of application
of e-government through analysis of examples, case studies and best practices.</td></tr>
<tr><td>11.</td><td colspan="6">Content of the course program: Introduction to advanced e-government models; Theoretical models of management; Stages of development of e-government and e-governance; Benefits and risks of e-government and e-governance; Digital divide; Theories and models of e-governance; Understanding of world experiences in the most important areas of application of e-Government and strategies for the application of information technologies in the public sector by areas of application: e-infrastructure, e-business; Application of information technologies in the public sector by areas of application: e-health, e-education, e-participation; Overview of successful strategies of the most advanced countries in the field
of e-government; Comparative analysis of ICT projects of the governments of the Republic of Macedonia and the countries of the European Union.
Determining the prospects for the application of information technology in the public sector and e-government in the Republic of North Macedonia.</td></tr>
<tr><td>12.</td><td colspan="6">Teaching methods: Lectures supported by slide presentations, interactive lectures, exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).</td></tr>
<tr><td>13.</td><td>Total available fund on time</td><td colspan="5">120 hours</td></tr>
<tr><td>14.</td><td>Allocation of available time</td><td colspan="5">45 + 5 + 20 + 15 + 35 = 120 hours</td></tr>
<tr><td rowspan="2">15.</td><td rowspan="2">Forms of teaching activities</td><td>15.1.</td><td colspan="2">Lectures - theoretical teaching .</td><td>45 hours</td></tr>
<tr><td>15.2.</td><td colspan="2">Exercises (laboratory, classroom), seminars, teamwork.</td><td>5 hours</td></tr>
<tr><td rowspan="2">16.</td><td rowspan="2">Other forms of activities</td><td>16.1.</td><td colspan="2">Project tasks</td><td>20 hours</td></tr>
<tr><td>16.2.</td><td colspan="2">Independent tasks</td><td>15 hours</td></tr>
</table>

		16.3.	Homework – assignments	35 hours
17.	Method of assessment			
	17.1.	Tests	40 points	
	17.2.	Individual work/project (presentation: written and oral)	50 points	
	17.3.	Activity and participation	10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)
			51 x to 60 points	6 (six) (E)
			61 x to 70 points	7 (seven) (D)
			from 71 to 80 points	8 (eight) (C)
			from 81 to 90 points	9 (nine) (B)
			from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction		Macedonian and English	
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods	

22. Literature

22.1. Required literature

Ord. Number	Author	Title	Publisher	Year
1.	Eric W. Welch	Research Handbook on E-government	UKIM Edward Elgar Publishing	2021
3.	Kelvin J. Bwalya	The e-government development discourse: Analyzing Contemporary and Future Growth Prospects in Developing and Emerging Economies	AOSIS	2018

22.2. Additional literature

Ord. Number	Author	Title	Publisher	Year
1.				
2.				
3.				

Annex no. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Advanced information theory and coding			
2.	Code	CTI3xE 23			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Prof. Dr. Ninoslav Marina			
9.	Prerequisites for attending the course	/			
10.	Objectives of the subject program (competencies): To introduce students to advanced information theory and advanced coding for modern ICT systems.				
11.	Course content: In this course, students will be introduced to advanced information theory, and topics on how to reach fundamental limits in data compression and transmission. The course also includes topics on advanced algebra with applications in coding theory. Some of the codes used in modern information and communication systems will be discussed in detail, such as turbo codes, low-density parity codes (LDPC), polar codes, and other codes that approach the Shannon limits. The final part of the course covers the use of these codes in modern networks, in multi-antenna systems, as well as the fundamental principles of information theory in security at the physical network level.				
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of evaluation				
	17.1.	Final Exam		40 points	
	17.2.	Seminar paper/project, written and oral presentation		50 points	

	17.3.	Activity and Participation			10 points
18.	Assessment criteria (points/grade)			up to 50 points	5 (five) (F)
				51 x to 60 points	6 (six) (E)
				61 x to 70 points	7 (seven) (D)
				from 71 to 80 points	8 (eight) (C)
				from 81 to 90 points	9 (nine) (B)
				from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2		
20.	Language of instruction		Macedonian and English		
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods		
22.	Literature				
	22.1.	Mandatory literature			
		Ord. Number	Author	Title	Publisher	Year
		1.	D. MacKay	Information Theory, Inference and Learning Algorithms	Cambridge Uni. Press	2003
		2.	T. Richardson, R. Urbanke	Modern Coding Theory	Cambridge Uni. Press	2008
		3.	R. Yeung	Information Theory and Network Coding	Springer	2008
	22.2.	Additional literature				
		Order No. / Nr.rend.	Author / Authors	Title / Title	Publisher / Boteusi	Year / Viti
		1.	T. Cover, J. Thomas	Elements of Information Theory	Wiley	2006
		2.	R. Gallagher	Information Theory and Reliable Communication	Wiley	1991
		3.	R. Gray	Entropy and Information Theory	Springer	2008

Annex no. 3		**Course program of the third cycle of studies**				
1.	Title of the course	Advanced methods for computer network security				
2.	Code	CTI3xE20				
3.	Study program	Computer Techniques and Informatics				
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering				
5.	Degree (first, second, third cycle)	Third cycle				
6.	Academic year / semester /	First year / winter/summer / First year Second semester	7.	Number of ECTS credits / Number of credits SETK	7.5	
8.	Teacher	Prof. Dr. Ninoslav Marina				
9.	Prerequisites for attending the course	/				
10.	Objectives of the subject program (competencies): Cryptographic algorithms and practical application in computer networks					
11.	Course content: In this course, students will be introduced to advanced topics in modern cryptography, such as elliptic curve cryptography and post-quantum cryptography. All algorithms and methods will be implemented on specific examples from cybersecurity, such as the Internet of Things, mobile applications, 5G/6G, blockchain technologies, distributed networks, and other advanced technologies. Implementation in Python, OpenSSL, and SAGE.					
12.	Teaching Methods: The course is based on 40 hours of lectures and 10 hours of laboratory exercises in Python . There will also be a project assignment, independent work assignments, and homework will be required.					
13.	Total available fund on time	120 hours				
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours				
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours		
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours		
16.	Other forms of activities	16.1.	Project tasks	30 hours		
		16.2.	Independent tasks	15 hours		
		16.3.	Homework – assignments	25 hours		
17.	Method of evaluation					
	17.1.	Final Exam		40 points		
	17.2.	Seminar paper/project, written and oral presentation		50 points		
	17.3.	Activity and Participation		10 points		
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)		

				51 x to 60 points	6 (six) (E)	
				61 x to 70 points	7 (seven) (D)	
				from 71 to 80 points	8 (eight) (C)	
				from 81 to 90 points	9 (nine) (B)	
				from 91 to 100 points	10 (ten) (A)	
19.	Requirement for signature and passing the final exam			Attendance at the Activities 15.1 and 15.2		
20.	Language of instruction			Macedonian and English		
21.	Method of monitoring the quality of teaching			In accordance with the university procedures and quality control methods		
22.	Literature					
	22.1.	Mandatory literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	N. Ferguson B. Schneier	Practical Cryptography	Wiley	2003
		2.	B. Schneier	Applied Cryptography: Protocols, Algorithms and Source Code in C	Wiley	2015
		3.	W. Stallings	Cryptography and Network Security: Principles and Practice	Pearson	2016
	22.2.	Additional literature				
		Order No.	Author	Title	Publisher	Year
		1.	J. Katz, Y. Lindell	Introduction to Modern Cryptography	Chapman and Hall	2014
		2.	L. Washington	Elliptic Curves: Number Theory and Cryptograph	Chapman and Hall	2008
		3.	D. Bernstein, J. Buchmann E. Dahmen	Post-Quantum Cryptography	Springer	2008

<table>
<tr><td colspan="2">Attachment No. 3</td><td colspan="4">Course program of the third cycle of studies</td></tr>
<tr><td>1.</td><td>Title of the course</td><td colspan="4">Advanced multimedia information systems</td></tr>
<tr><td>2.</td><td>Code</td><td colspan="4">CTI3xE 14</td></tr>
<tr><td>3.</td><td>Study program</td><td colspan="4">Computer Techniques and Informatics</td></tr>
<tr><td>4.</td><td>Organizer of the study program (unit, i.e. institute, department, division)</td><td colspan="4">UIST, Faculty of computer sciences and engineering</td></tr>
<tr><td>5.</td><td>Degree (first, second, third cycle)</td><td colspan="4">Third cycle</td></tr>
<tr><td>6.</td><td>Academic year / semester /</td><td>First year / winter/summer</td><td>7.</td><td>Number of ECTS credits</td><td>7.5</td></tr>
<tr><td>8.</td><td>Teacher</td><td colspan="4">Assoc. Prof. Dr. Anis Sefidanoski</td></tr>
<tr><td>9.</td><td>Prerequisites for attending the course</td><td colspan="4">/</td></tr>
<tr><td>10.</td><td colspan="5">Objectives of the subject program (competencies):
Mastering knowledge about designs and implementation of advanced multimedia information systems.</td></tr>
<tr><td>11.</td><td colspan="5">Course content:
Modeling, analysis and design of multimedia information systems. Data management, advanced database systems, design and applications in digital form. Multimedia information systems, digital form and knowledge management. Ontologies for annotation and retrieval of multimedia data. Basic elements of the course are organization, storage, fusion, indexing, access, user-computer interfaces, searching (usually by content) and processing multimedia data in distributed mobile and other environments. For multimedia data, low-level feature extraction, appropriate descriptors (based on shape, color, texture, movement, etc.), structural and semantic aspects (of high level) are of particular importance. MPEG and other standards are part of the course. They will be
3D models and their search, as well as learning and relevant feedback, are also considered. connection. Special attention will be paid to content-based indexing and search, as well as semantic-based and affect-based indexing and multimedia data search. Similarity metrics in 3D will also be studied.
• models, images, sound and video.</td></tr>
<tr><td>12.</td><td colspan="5">Teaching methods:
Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).</td></tr>
<tr><td>13.</td><td>Total available fund on time</td><td colspan="4">120 hours</td></tr>
<tr><td>14.</td><td>Allocation of available time</td><td colspan="4">45 + 5 + 30 + 15 + 25 = 120 hours</td></tr>
<tr><td>15.</td><td>Forms of teaching activities</td><td>15.1.</td><td colspan="2">Lectures - theoretical teaching .</td><td>45 hours</td></tr>
</table>

		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours
16.	Other forms of activities	16.1.	Project tasks	30 hours
		16.2.	Independent tasks	15 hours
		16.3.	Homework – assignments	25 hours

17.	Method of evaluation		
	17.1.	Final Exam	40 points
	17.2.	Seminar paper/project, written and oral presentation	50 points
	17.3.	Activity and Participation	10 points

18.	Assessment criteria (points/grade)	up to 50 points	5 (five) (F) 5 (five) (F)
		51 x to 60 points	6 (six) (E) 6 (six) (E)
		61 x to 70 points	7 (seven) (D) 7 (seven) (D)
		from 71 to 80 points	8 (eight) (C) 8 (eight) (C)
		from 81 to 90 points	9 (nine) (B) 9 (nine) (B)
		from 91 to 100 points	10 (ten) (A) 10 (ten) (A)
19.	Requirement for signature and passing the final exam	Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction	Macedonian and English	
21.	Method of monitoring the quality of teaching	In accordance with the university procedures and quality control methods	

22.	Literature					
	22.1.	Mandatory literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	Faloutsos, CH.	Searching Multimedia Databases by Content	Clower	1996
		2.	Dr. Grifoni	Multimodal Human Computer Interaction and Pervasive Services	Information Science Reference	2009
		3.				
	22.2.	Additional literature				
		Order No.	Author	Title	Publisher	Year

		1.				
		2.				
		3.				

Annex no. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Advanced optimization methods			
2.	Code	CTI3xE22			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Prof. Dr. Ninoslav Marina			
9.	Prerequisites for attending the course	/			
10.	Objectives of the subject program (competencies): To introduce students to advanced optimization methods and their applications.				
11.	Course content: In this course, students will be introduced to advanced optimization methods and their implementation in Python and Matlab. Linear and convex optimization as well as optimization with constraints will be discussed and explained in detail. Multidimensional optimization using matrices will also be discussed.				
12.	Learning methods: The course is based on 40 hours of lectures and 10 hours of laboratory exercises in Python and Matlab . There will also be a project assignment, independent work assignments, and homework required.				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	40 + 10 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	40 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	10 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of evaluation				
	17.1.	Final Exam		40 points	
	17.2.	Seminar paper/project, written and oral presentation		50 points	
	17.3.	Activity and Participation		10 points	
18.	Assessment criteria (points/grade)	up to 50 points		5 (five) (F) 5 (five) (F)	
		51 x to 60 points		6 (six) (E)	

						6 (six) (E)
				61 x to 70 points		7 (seven) (D) 7 (seven) (D)
				from 71 to 80 points		8 (eight) (C) 8 (eight) (C)
				from 81 to 90 points		9 (nine) (B) 9 (nine) (B)
				from 91 to 100 points		10 (ten) (A) 10 (ten) (A)
19.	Requirement for signature and passing the final exam			Attendance at the Activities 15.1 and 15.2		
20.	Language of instruction			Macedonian and English		
21.	Method of monitoring the quality of teaching			In accordance with the university procedures and quality control methods		
22.	Literature					
	22.1.	Mandatory literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	S. Boyd, L. Vandenberghe	Convex Optimization	Cambridge Uni. Press	2004
		2.	D. Bertsekas	Convex Optimization Theory	Athena Scientific	2009
		3.	D. Luenberger	Optimization by Vector Space Methods	Wiley	1997
	22.2.	Additional literature				
		Order No.	Author	Title	Publisher	Year
		1.	P.-A. Absil, R. Mahony, R. Sepulchre	Optimization Algorithms on Matrix Manifolds	Princeton Uni. Press	2007
		2.	G. Calafiore, L. El Ghaoui	Optimization Models	Cambridge Uni. Press	2014
		3.	D. Bertsekas	Nonlinear Programming	Athena Scientific	2016

Attachment No. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Advanced parallel programming			
2.	Code	CTI3xE07			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle) /	Third cycle			
6.	Academic year / semester	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Associate Professor Dr. Atanas Hristov			
9.	Prerequisites for enrolling in the course	/			
10.	Objectives of the subject program (competencies): The main goal of this course is to introduce students to advanced concepts of parallel programming and GPU programming. Upon completion of the course, students will be able to independently use high-performance computing systems and write appropriate software solutions. For the purposes of the course, students will become familiar with and work with CUDA C.				
11.	Course content: Introduction. Parallel processing concepts. Introduction to graphics processing units (GPU). Introduction in GPU programming . GPU programming and CUDA. Parallel models on communication in CUDA – map, scatter, gather, reduce and Fig . . Optimizing GPU - CUDA programs. Advanced concepts of parallel programming. Parallel processing patterns . Examples of parallel algorithms.				
12.	Learning methods: Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	

		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours
16.	Other forms of activities	16.1.	Project tasks	30 hours
		16.2.	Independent tasks	15 hours
		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points
	17.3.	Activity and Participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)
			51 to 60 points	6 (six) (E)
			61 to 70 points	7 (seven) (D)
			from 71 to 80 points	8 (eight) (C)
			from 81 to 90 points	9 (nine) (B)
			from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction		Macedonian and English	
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods	

22.	Literature					
	22.1.	Required literature				
		Ord. Number	Author	Title	Publisher	Year

		1.	Dr. Brian Tuomanen	Hands-On GPU Programming with Python and CUDA: Explore high-performance parallel computing with CUDA	Packt Publishing	2018
		2.				
		3.				
	22.2.	Additional literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	David B. Kirk, Wen-mei W. Hwu	Programming Massively Parallel Processors	Morgan Kaufmann	20 17
		2.				
		3.				

Прилог бр.3		**Course program of the third cycle of studies**			
1.	Title of the course	Big data management and analysis			
2.	Code	CTI3xE0 9			
3.	Study program	Computer techniques and informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	University of Information Sciences and Technologies "St. Paul the Apostle" - Ohrid; Faculty of Computer Science and Engineering - FKNI			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number on EKTS loans	7.5
8.	Teacher	Wonr. prof. Dr. Dijana Capeska Bogatinoska			
9.	Prerequisites for attending the course	/			
10.	**Course Objectives (Competencies):** Students will be introduced to big data architectures and infrastructures , as well as tools and techniques for big data analysis . They will explore issues related to big data management and develop specialized knowledge and understanding regarding big data storage, big data models , and big data programming interfaces .				
11.	**Course Content:** 1. Big Data Basics 1.1. Explanation and description of the main features 1.2. Categories and examples of big data 1.3. Big data challenges 2. Big data management 2.1. Key issues for managing big data 2.2. Big Data Management Service Provisions 2.3. Security, ethical and legal regulations 3. Storage, data models, and programming interfaces used for big data 3.1. New storage organizations and the potential implications of their use 3.2. Big data storage 3.3. Big data modeling (structured and unstructured) 3.4. Real-time data modeling 3.5. Comparison of programming interface models (Hadoop, MapReduce, Spark, Yarn) 4. Big data architecture 4.1. Data warehousing techniques (MapReduce, HDFS, Yarn) 4.2. NoSQL comparison and relational databases 4.3. Brewers theorem 4.4. Analysis of database frameworks (for example: MongoDB, MySQL, and Cassandra) 5. Big data infrastructures 5.1. Data usage with cloud-based networks 5.2. Distributed file systems (Specialized applications, e.g. GFS) 5.3. Ownership and financial implications of using the cloud 6. Big data analysis tools and techniques				

	6.1. Gartner's model 6.2. Big data analysis using basic machine learning algorithms 6.3. Use of artificial intelligence in big data applications 6.4. Types of neural networks 6.5. Use of hash function (Bloom filters and their application in data mining)				
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of assessment				
	17.1.	Final Exam		40 points	
	17.2.	Seminar paper/project, written and oral presentation		50 points	
	17.3.	Activity and Participation		10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F) 5 (five) (F)	
			51 x to 60 points	6 (six) (E) 6 (six) (E)	
			61 x to 70 points	7 (seven) (D) 7 (seven) (D)	
			from 71 to 80 points	8 (eight) (C) 8 (eight) (C)	
			from 81 to 90 points	9 (nine) (B) 9 (nine) (B)	
			from 91 to 100 points	10 (ten) (A) 10 (ten) (A)	
19.	Requirement for signature and passing the final exam	Attendance at the Activities 15.1 and 15.2			
20.	Language of instruction	Macedonian and English			
21.	Method of monitoring the quality of teaching	In accordance with the university procedures and quality control methods			
22.	Literature				
	22.1.	Compulsory literature			
		Ord. Number	Author	Title	Publisher	Year

		1.	T. Erl and W. Khattak	Big Data Fundamentals: Concepts, Drivers, and Techniques.	Prentice Hall	2016
		2.	D. Stephenson	Big Data Demystified: How to use big data, data science and AI to make better business decisions and gain competitive advantage	Pearson Education	2018
		3.	K. Adam, MAI Fakharaldien, JM Zain and MA Majid	Big Data Management and Analysis	University of Malaysia Pahang	2014
		4.	F. Almeida	Benefits, Challenges and Tools of Big Data Management	Journal of Systems Integration	2017
		5.	PJ Sadalage and M. Fowler	NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence	RR Donnelley	2013
	22.2.	Additional literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	W. Lemahieu, S. vanden Broucke and B. Baesens	Principles of Database Management: Practical Guide to Storing, Managing and Analyzing Big and Small Data	Cambridge University Press	2018
		2.	K.-C. Li, H. Jiang and A. Y. Zomaya	Big Data Management and Processing	CRC Press	2017
		3.	A. K. Somani and G. C. Deka	Big Data Analytics. Tools and Technology for Effective Planning	CRC Press	2018

Annex no. 3		**Course program of the third cycle of studies /**			
1.	Title of the course	E-business Technologies			
2.	Code	CTI3xE25			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter / summer	7.	Number of ECTS credits	7.5
8.	Teacher	Assoc. Prof. Jovanka Damoska Sekuloska			
9.	Prerequisites for attending the course				
10.	Objectives of the course program (competences) : The objective of this course is to enable students to recognise the role of the Internet in organisations' business decision-making processes. Students will acquire knowledge and understanding of innovative e-business technologies and business models, and of their implementation as strategic tools for creating added value and enhancing the competitiveness of modern businesses.				
11.	Course Content: 1. Advanced e-Business Models - Examination of contemporary digital business models and the ways organizations create, deliver, and capture value in the digital economy. 2. Sharing Economy - Analysis of business models based on the sharing of resources, assets, and services through digital platforms. 3. Platform Economy - Study of platform-based businesses that connect multiple groups of users and facilitate digital transactions and interactions. 4. Peer-to-Peer (P2P) e-Business Models - Exploration of decentralized business models that enable direct exchanges between individuals without traditional intermediaries. 5. Web 2.0, Web 3.0, and Web 4.0 Technologies - Overview of the evolution of web technologies, including social web applications, semantic web concepts, blockchain-based systems, and intelligent web services. 6. Intermediary Services for e-Commerce Support - Introduction to payment gateways, logistics providers, digital marketplaces, and other services that facilitate electronic commerce. 7. Implementation of e-Business Technologies within the Enterprise Value Chain - Analysis of how digital technologies can be integrated into business processes to improve efficiency, productivity, and value creation. 8. e-CRM and Consumer Behavior Analytics - Study of electronic customer relationship management systems and the use of data analytics to understand and predict customer behavior. 9. e-SCM and Supply Chain Analytics				

	- Examination of digital supply chain management solutions and analytical tools for optimizing supply chain performance and decision-making. 10. Successful e-Business Technology Implementation Projects - Review of real-world case studies and best practices demonstrating the successful adoption and strategic use of e-business technologies in organizations.					
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).					
13.	Total available fund on time	120 hours				
14.	Allocation of available time	45 + 5 + 20 + 15 + 35 = 120 hours				
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours		
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours		
16.	Other forms of activities	16.1.	Project tasks	20 hours		
		16.2.	Independent tasks	15 hours		
		16.3.	Homework – assignments	35 hours		
17.	Method of assessment					
	17.1.	Final exam		40 points		
	17.2.	Seminar paper/project, written and oral presentation		50 points		
	17.3.	Activity and participation		10 points		
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)		
			51 to 60 points	6 (six) (E)		
			61 to 70 points	7 (seven) (D)		
			from 71 to 80 points	8 (eight) (C)		
			from 81 to 90 points	9 (nine) (B)		
			from 91 to 100 points	10 (ten) (A)		
19.	Requirement for signature and passing the final exam	Attendance at the Activities 15.1 and 15.2				
20.	Language of instruction	Macedonian and English				
21.	Method of monitoring the quality of teaching	In accordance with the university procedures and quality control methods				
22.	Literature					
	22.1.	Required literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	Dave Chaffey, Tanya Hemphill and David Edmundson-Bird	Digital business and e-commerce management 7 th ed.	Pearson	2019

		2 .	Kenneth C. Laudon and Carol Guercio Traver	E-commerce 2018: Business, Technology, Society 14/ed	Pearson	2018
		3.	Judah Phillips	Ecommerce Analytics: Analyze and Improve the Impact of Your Digital Strategy	Pearson FT Press	2016
	22.2.	Additional literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	Turban, King, Lee, Ting-Peng Liang, Deborrah C. Turban	Electronic Commerce: A Managerial and Social Networks Perspective 8/ed	Springer	2015
		2.	Tawfik Jelassi and Albrecht Enders	Strategies for e-Business concepts and cases	Pearson	2011
		3.				

Annex no. 3		**Course program of the third cycle of studies /**			
1.	Title of the course	Expert systems and multimedia			
2.	Code	CTI3xE10			
3.	Study program	Computer techniques and informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits /	7.5
8.	Teacher	Prof. Dr. Anis Sefidanoski			
9.	Prerequisites for attending the course	/			
10.	Objectives of the subject program (competencies): To introduce the concepts of intelligent agents using advanced multimedia interfaces, search and interaction with smart agents, planning, decision-making, learning and training of expert systems using multimedia interfaces				

11.	Course content: 1. To study the idea of combining intelligent agents and multimedia systems 2. To elaborate paradigms for representing knowledge using advanced interactive multimedia interfaces 4. To construct techniques and methods for visualization of intelligent agents and their generated content using virtual reality, holography, etc. 5. To study and practically develop concepts for integrating multimedia into expert development environments			
12.	Teaching methods: This course is based on 45 hours of lectures, supplemented by the study of practical tasks and exercises, consultations with the subject professor, preparation of a final project, as well as the presentation of a scientific paper in the field in an international journal.			
13.	Total available fund on time	120 hours		
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours		
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours
16.	Other forms of activities	16.1.	Project tasks	30 hours
		16.2.	Independent tasks	15 hours
		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points

	17.3.	Activity and Participation			10 points	
18.	Assessment criteria (points/grade)			up to 50 points	5 (five) (F) 5 (pes ë) (F)	
				51 x to 60 points	6 (six) (E) 6 (six) (E)	
				61 x to 70 points	7 (seven) (D) 7 (seven) (D)	
				from 71 to 80 points	8 (eight) (C) 8 (tet ë) (C)	
				from 81 to 90 points	9 (nine) (B) 9 (n ë nt ë) (B)	
				from 91 to 100 points	10 (ten) (A) 10 (ten) (A)	
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2			
20.	Language of instruction		Macedonian and English			
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods			
22.	Literature					
	22.1.	Required literature				
		Ord. Number	Ord. Number	Ord. Number	Ord. Number	Ord. Number

		1.	Stuart J. Russell, Peter Norvig	Artificial Intelligence: A Modern Approach (4th Global ed.)	Prentice Hall	2022
		2.				
		3.				
	22.2.	Additional literature				
		Ord. Number	Ord. Number	Ord. Number	Ord. Number	Ord. Number
		1.				
		2.				

Annex no. 3 / Shtojca nr. 3		**Course program of the third cycle of studies /**			
1.	Title of the course	Generative artificial intelligence			
2.	Code	CTI3xE12			
3.	Study program	Computer techniques and informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Prof. Dr. Anis Sefidanoski			
9.	Prerequisites for attending the course	/			
10.	Objectives of the subject program (competencies): This course offers an overview of generative models based on artificial intelligence that aim to predict the representation of data, i.e. their distribution. To provide students with advanced techniques and deeper theoretical and practical knowledge in modern machine learning techniques.				

<table>
<tr><td>11.</td><td colspan="4">• Principles of generative models
• Bayesian network and optimization
• Random Markov fields
• Boltzmann machines
• Variational automatic encoders
• Sampling and conclusions
• Variational locking
• Variational methods
• Neural networks
• Exponential family
• Graphical models and generative learning
• Sampling and conclusions
• Variational learning
• Generative models
• Deep learning techniques
• Generating images and animations using AI
• Generating sound and music using AI
• Creating chatbots and intelligent agents</td></tr>
<tr><td>12.</td><td colspan="4">Teaching methods:
This course is based on 45 hours of lectures, supplemented by the study of practical tasks and exercises, consultations with the subject professor, preparation of a final project, as well as the presentation of a scientific paper in the field in an international journal.</td></tr>
<tr><td>13.</td><td>Total available fund on time</td><td colspan="3">120 hours</td></tr>
<tr><td>14.</td><td>Allocation of available time</td><td colspan="3">45 + 5 + 30 + 15 + 25 = 120 hours</td></tr>
<tr><td rowspan="2">15.</td><td rowspan="2">Forms of teaching activities</td><td>15.1.</td><td>Lectures - theoretical teaching .</td><td>45 hours</td></tr>
<tr><td>15.2.</td><td>Exercises (laboratory, classroom), seminars, teamwork.</td><td>5 hours</td></tr>
<tr><td rowspan="2">16.</td><td rowspan="2">Other forms of activities</td><td>16.1.</td><td>Project tasks</td><td>30 hours</td></tr>
<tr><td>16.2.</td><td>Independent tasks</td><td>15 hours</td></tr>
</table>

		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points
	17.3.	Activity and Participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F) 5 (pes ë) (F)
			51 x to 60 points	6 (six) (E) 6 (six) (E)
			61 x to 70 points	7 (seven) (D) 7 (seven) (D)
			from 71 to 80 points	8 (eight) (C) 8 (tet ë) (C)
			from 81 to 90 points	9 (nine) (B) 9 (n ë nt ë) (B)
			from 91 to 100 points	10 (ten) (A) 10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction		Macedonian and English	
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods	

22.	Literature					
	22.1.	Obligatory literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	David Foster	Generative Deep Learning	O'Reilly Media, Inc.	2023
		2.				
		3.				
	22.2.	Additional literature				
		Order No.	Author	Title	Publisher	Year
		1.				
		2.				
		3.				

Annex no. 3 / Shtojca nr. 3		**Course program of the third cycle of studies /**			
1.	Title of the course	Holography and mixed reality			
2.	Code	CTI3xE13			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Prof. Dr. Anis Sefidanoski			
9.	Prerequisites for attending the course	/			
10.	Objectives of the subject program (competencies): To comprehensively unify the principles for defining system requirements and designing advanced mixed reality systems (Mixed Reality). Reality), construction, evaluation, implementation and management of the effective use of holograms based on digital technologies.				

<table>
<tr><td>11.</td><td colspan="4">Course content:
• Best practices in mixed reality, including design, hologram prototypes, and ethical code of conduct with their applications
• A critical framework for evaluating current and emerging mixed reality technologies and their applications
• Design and technological foundations of digital holography for mixed experiences
• Input devices – controllers, motion trackers, and motion capture technologies for tracking, navigation, and haptic control.
• Mixed reality output devices
• 3D interactive and procedural graphics for holograms
• Mixed surround sound
• Systems architecture and integrative immersive media platforms
• Rapid prototyping and physical computing
• MR programming</td></tr>
<tr><td>12.</td><td colspan="4">Teaching methods:
This course is based on 45 hours of lectures, supplemented by the study of practical tasks and exercises, consultations with the subject professor, preparation of a final project, as well as the presentation of a scientific paper in the field in an international journal.</td></tr>
<tr><td>13.</td><td>Total available fund on time</td><td colspan="3">120 hours</td></tr>
<tr><td>14.</td><td>Allocation of available time</td><td colspan="3">45 + 5 + 30 + 15 + 25 = 120 hours</td></tr>
<tr><td rowspan="2">15.</td><td rowspan="2">Forms of teaching activities</td><td>15.1.</td><td>Lectures - theoretical teaching .</td><td>45 hours</td></tr>
<tr><td>15.2.</td><td>Exercises (laboratory, classroom), seminars, teamwork.</td><td>5 hours</td></tr>
<tr><td rowspan="3">16.</td><td rowspan="3">Other forms of activities</td><td>16.1.</td><td>Project tasks</td><td>30 hours</td></tr>
<tr><td>16.2.</td><td>Independent tasks</td><td>15 hours</td></tr>
<tr><td>16.3.</td><td>Homework – assignments</td><td>25 hours</td></tr>
<tr><td>17.</td><td colspan="4">Method of assessment</td></tr>
</table>

	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points
	17.3.	Activity and Participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F) 5 (pes ë) (F)
			51 x to 60 points	6 (six) (E) 6 (six) (E)
			61 x to 70 points	7 (seven) (D) 7 (seven) (D)
			from 71 to 80 points	8 (eight) (C) 8 (tet ë) (C)
			from 81 to 90 points	9 (nine) (B) 9 (n ë nt ë) (B)
			from 91 to 100 points	10 (ten) (A) 10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction		Macedonian and English	
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods	
22.	Literature			
	22.1.	Obligatory literature		

		Ord. Number / Numri rend.	Author / Authors	Title / Title	Publisher / Boteusi	Year / Viti
		1.	Kelly S. Hale, Kay M. Stanney	Handbook of Virtual Environments : Design, Implementation, and Applications, Second Edition	CRC Press	2014
		2.				
		3.				
	22.2.	Additional literature				
		Order No. / Nr.rend.	Author / Authors	Title / Title	Publisher / Boteusi	Year / Viti
		1.				
		2.				
		3.				

Attachment No. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Modern Cloud Techniques			
2.	Code	CTI3xE16			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Associate prof. Aneta Velkoska			
9.	Prerequisites for enrolling in the course	/			
10.	Objectives of the subject program (competencies): This course provides students with solid knowledge of cloud technologies and cloud data processing. Upon completion of the course, students will be able to analyze the components of cloud computing from both a technical and business perspective, evaluate different cloud development tools, work with cloud services in real time, and analyze case studies in order to derive the best models and best practices for developing and implementing cloud-based applications.				
11.	Course content: Definition of cloud computing, types of cloud, and cloud services. Advantages and challenges of cloud computing, evolution of cloud computing, use cases and applications, and cloud business models – major players in cloud computing. Database as a service, monitoring as a service, communication as a service. Application service providers – Google, Amazon EC2, Microsoft Azure, Salesforce. Working with MapReduce, GFS, HDFS, Hadoop frameworks. Cloud data storage infrastructure. Virtualization technologies.				
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, practical exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and presentation of project assignments and seminar papers, and learning in an electronic environment (forums and consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	

		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points
	17.3.	Activity and participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)
			51 x to 60 points	6 (six) (E)
			61 x to 70 points	7 (seven) (D)
			from 71 to 80 points	8 (eight) (C)
			from 81 to 90 points	9 (nine) (B)
			from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam		Attendance at the Activities 15.1 and 15.2	
20.	Language of instruction		Macedonian and English	
21.	Method of monitoring the quality of teaching		In accordance with the university procedures and quality control methods	

22. Literature

22.1. Required literature

Ord. Number	Author	Title	Publisher	Year
1.	Bloor R., Kanfman M., Halper F. Judith Hurwitz	Cloud Computing for Dummies	John Wiley & Sons, Inc.	20 12
2.	John Rittinghouse & James Ransome	Cloud Computing Implementation Management and Strategy	CRC Press,	2010
3.				

22.2. Additional literature

Ord. Number	Author	Title	Publisher	Year
1.				
2.				
3.				

<table>
<tr><td colspan="2">Attachment No. 3</td><td colspan="4">Course program of the third cycle of studies</td></tr>
<tr><td>1.</td><td>Title of the course</td><td colspan="4">Modern concepts of cybersecurity and advanced cryptography</td></tr>
<tr><td>2.</td><td>Code</td><td colspan="4">CTI3xE0 3</td></tr>
<tr><td>3.</td><td>Study program</td><td colspan="4">Computer Techniques and Informatics</td></tr>
<tr><td>4.</td><td>Organizer of the study program (unit, i.e. institute, department, division)</td><td colspan="4">UIST, Faculty of computer sciences and engineering</td></tr>
<tr><td>5.</td><td>Degree (first, second, third cycle)</td><td colspan="4">Third cycle</td></tr>
<tr><td>6.</td><td>Academic year / semester /</td><td>First year / winter/summer</td><td>7.</td><td>Number of ECTS credits</td><td>7.5</td></tr>
<tr><td>8.</td><td>Teacher</td><td colspan="4">Full Professor Dr. Ustiana Rechkoska Shikoska</td></tr>
<tr><td>9.</td><td>Prerequisites for attending the course</td><td colspan="4">/</td></tr>
<tr><td>10.</td><td colspan="5">Course objectives (competences): Upon completion of this course, the student will be able to:
Examines the fundamental concepts and elements of Cybersecurity from the perspective of people, processes, and technologies
Applying a comprehensive overview of the concepts and terminology of Cybersecurity and advanced cryptography
Examines basic threats and protective mechanisms for physical, personal, computer and application level security
Identifies basic threats and protective mechanisms for Internet, network, mobile, wireless, and web security
Apply basic information security principles to defend against cyber security threats and protect information devices
Researches common law on Cybersecurity, standards and best practices.</td></tr>
<tr><td>11.</td><td colspan="5">Course content:
Fundamentals of Computer and Cyber Forensics – Introduction to Computers, Computer History, Software, Hardware, Classification, Computer Input/Output Devices, Windows, DOS Prompt Commands, Basic Computer Terminology, Internet, Networking, Computer Storage, Mobile Phone Forensics, Computer Ethics and Application Programs, Fundamentals of Cyber Forensics – Introduction to Cyber Forensics, Storage Fundamentals, File System Concepts, Data Recovery, Operating System Software and Basic Terminology
Data and Evidence Recovery – Introduction to deleted document recovery, formatted partition recovery, data recovery tools, Data recovery procedures and tools. Preservation and secure handling of original documents, documenting “chain of custody”, Full time analysis of computer documents based on document creation, document modification and document access. Data recovery used by the Internet, Recovery of Swap documents, Temporary documents, Cache documents. Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK) etc. Using computer forensic software tools to cross-validate findings in computer cases based on evidence.
Cybercrime and cyber law – introduction to ICT law and Cybercrime – Internet, Hacking, Cracking, Viruses, Virus attacks, Pornography, Software privacy, Intellectual property, Legal system of information technologies, Social engineering, message bombs, Exploitation of vulnerabilities and Cybersecurity.</td></tr>
</table>

	4. Cyber Forensic Investigation – Introduction to Cyber Forensic Investigation, Investigation Tools, e-Discovery, Digital Evidence Collection, Evidence Protection, Email Investigation, Email Tracking, IP Address Tracking, Email Recovery, Encryption and Decryption Methods, Computer Recovery and Seizure, Recovering Deleted Evidence, Password Recovery. Cyber Security – Introduction to Cyber Security, Implementation of Hardware-Based Security, Software-Based Firewall, Security Standards, Threat Level Assessment, Forming an Incident Response Team, Reporting Cyber Crime, Operating System Attacks, Application Attacks, Reverse Engineering and Cracking Techniques, and Financial Fraud.			
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).			
13.	Total available fund on time	120 hours		
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours		
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours
16.	Other forms of activities	16.1.	Project tasks	30 hours
		16.2.	Independent tasks	15 hours
		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Final Exam		40 points
	17.2.	Seminar paper/project, written and oral presentation		50 points
	17.3.	Activity and Participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F) 5 (five) (F)
			51 x to 60 points	6 (six) (E) 6 (six) (E)
			61 x to 70 points	7 (seven) (D) 7 (seven) (D)
			from 71 to 80 points	8 (eight) (C) 8 (eight) (C)
			from 81 to 90 points	9 (nine) (B) 9 (nine) (B)
			from 91 to 100 points	10 (ten) (A) 10 (ten) (A)
19.	Requirement for signature and passing the final exam	Attendance at the Activities 15.1 and 15.2		
20.	Language of instruction	Macedonian and English		
21.	Method of monitoring the quality of teaching	In accordance with the university procedures and quality control methods		

22.	Literature					
	22.1.	Compulsory literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	LeClair, J.	Protecting our future: educating a cybersecurity workforce	Excelsior College Press, NY	2013
		2.				
		3.				
	22.2.	literature				
		Order No.	Author	Title	Publisher	Year
		1.	Pfleeger, CP	Security in Computing	5th Edition, Prentice Hall	2010
		2.	Schneier, Bruce.	Applied Cryptography	Second Edition, John Wiley & Sons	1996
		3.				

Attachment No. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Modern methods for parallel processing			
2.	Code	CTI3xE06			
3.	Study program	Computer techniques and informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	University of Information Sciences and Technologies "St. Paul the Apostle" - Ohrid; Faculty of Computer Science and Engineering - FCSE			
5.	Degree (first, second, third cycle) /	Third cycle			
6.	Academic year / semester	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Associate Professor Dr. Atanas Hristov			
9.	Prerequisites for enrolling in the course	/			
10.	Objectives of the subject program (competencies): The main goal of this course is to equip students with the skills to analyze and design methods for parallel architectures and parallel programs. Upon completion of this course, students will have a clear understanding of modern multi-core and distributed architectures, learn the basics of shared and distributed memory systems, and parallel programs.				
11.	Course content: architectures , basic concepts of parallel algorithm creation and parallel programming. Comparison of programming methodologies for multiprocessor systems with distributed and shared memory, vector processors and systolic arrays. Comparison of static and dynamic task distribution in a grid environment, using clusters and virtualization. Review of methods for analyzing parallel architectures and programs. Introduction of techniques and necessary skills for measuring performance and solving scalability problems of parallel solutions. Future directions in parallel processing and experimental methodologies are discussed to provide direction for the development of new solutions to existing problems.				
12.	Learning methods: Lectures supported by slide presentations, interactive lectures, exercises (use of equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).				
13.	Total available fund on time	120 hours			

14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours		
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours
16.	Other forms of activities	16.1.	Project tasks	30 hours
		16.2.	Independent tasks	15 hours
		16.3.	Homework – assignments	25 hours
17.	Method of assessment			
	17.1.	Tests		40 points
	17.2.	Individual work/project (presentation: written and oral)		50 points
	17.3.	Activity and participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)
			51 x to 60 points	6 (six) (E)
			61 x to 70 points	7 (seven) (D)
			from 71 to 80 points	8 (eight) (C)
			from 81 to 90 points	9 (nine) (B)
			from 91 to 100 points	10 (ten) (A)
19.	Requirement for signature and passing the final exam	implemented activities 15.1 and 15.2		
20.	Language of instruction	Macedonian and English		
21.	Method of monitoring the quality of teaching	Monitoring UINT control procedures		
22.	Literature			

	22.1.	Required literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	Peter Pacheco, Matthew Malensek	An Introduction to Parallel Programming	Elsevier	2021
		2.				
		3.				
	22.2.	Additional literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	David B. Kirk, Wen-mei W. Hwu	Programming Massively Parallel Processors	Morgan Kaufmann	20 17
		2.				
		3.				

Прилог бр.3		**Предметна програма од третиот циклус на студии**			
1.	Title of the teaching subject	Optimization Modelling			
2.	Code	CTI3xE18			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	third cycle			
6.	Academic year / semester	Second year / fourth semester	7.	ECTS	7,5
8.	Teacher	Prof. Elena Hadzieva, PhD			
9.	Prerequisites for Attending the Course	Mathematics 1, Mathematics 2, Linear Algebra, Optimisation Methods, Mathematical Modelling			
10.	**Course Objectives (Competencies):** Students will become familiar with the concept of a mathematical model, as well as the historical development of mathematical modeling and the classification of optimization models. They will learn the fundamental concepts of optimization modeling and acquire the ability to formulate mathematical models for real-world optimization problems. Furthermore, students will study a variety of modeling techniques and methods for solving optimization problems, both theoretically and practically, using Python (Pyomo)..				
11.	**Course Content:** Mathematical models. Fundamental concepts in optimization modeling. Classification of optimization problems. Decision-making processes. Model formulation. Model sensitivity analysis. Solution testing and validation. Modeling techniques: expressing variables in terms of other variables; maintaining specified relationships among variables; min–max and max–min objective functions; either–or conditions; yes–or–no decisions; k-out-of-n constraints; mutually exclusive alternatives; approximation functions. Application of these techniques to practical examples. Various solution approaches implemented in Python.				
12.	Interactive teaching – 45 hours and interactive tutorials – 30 hours, individual work through homework and projects.				
13.	Total Available Time Allocation	120 hours			
14.	Distribution of Available Time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of Teaching Activities	15.1.	Lectures – theoretical instruction	45 hours	
		15.2.	Exercises (laboratory, auditory), seminars, teamwork	5 hours	
16.	Other forms of activities	16.1.	Project Assignments	30 hours	
		16.2.	Independent Assignments	15 hours	
		16.3.	Home Learning – Assignments	25 hours	
17.	Assessment Method				
	17.1.	Final Exam		50 points	
	17.2.	Seminar paper/project, written and oral presentation		40 points	
	17.3.	Activity and Participation		10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)	

				from 51 to 60 points	6 (six) (E)	
				from 61 to 70 points	7 (seven) (D)	
				from 71 to 80 points	8 (eight) (C)	
				from 81 to 90 points	9 (nine) (B)	
				from 91 to 100 points	10 (ten) (A)	
19.	Requirements for Signature and Taking the Final Exam			Attendance at the Activities 15.1 and 15.2		
20.	Language of Instruction			Macedonian and English		
21.	Method for monitoring the quality of teaching			In accordance with the university procedures and quality control methods		
22.	Literature					
	22.1.	Mandatory Literature				
		No.	Author	Title	Publisher	Year
		1.	Ruhul A. Sarker, Charles S. Newton	Optimization Modelling, A practical Approach,	CRC Press, Taylor & Francis Group	2008
		2.	William E. Heart, Carl D. Laird, Jean-Paul Watson, David L. Woodruff, Gabriel A. Hackebeil, Bethany L. Nicholson, John D Siirola	Pyomo – Optimization Modeling in Python, second Edition	Springer	2017
		3.				
	22.2.	Additional Literature				
		No.	Author	Title	Publisher	Year
		1.	Serge Kruk	Practical Python AI Projects, Mathematical Models of Optimization	Apress, distributed by Springer Science + Business Media New York	2018
		2.	Jorge Nocedal, Stephen J. Wright	Numerical Optimization	Springer-Verlag New York	2006
		3.				

<table>
<tr><td colspan="2">Attachment No. 3</td><td colspan="4">Course program of the third cycle of studies</td></tr>
<tr><td>1.</td><td>Title of the course</td><td colspan="4">Research Methodology in Computer Engineering and Informatics</td></tr>
<tr><td>2.</td><td>Code</td><td colspan="4">CTI31M2</td></tr>
<tr><td>3.</td><td>Study program</td><td colspan="4">Computer Techniques and Informatics</td></tr>
<tr><td>4.</td><td>Organizer of the study program (unit, i.e. institute, department, division)</td><td colspan="4">UIST, Faculty of computer sciences and engineering</td></tr>
<tr><td>5.</td><td>Degree (first, second, third cycle)</td><td colspan="4">third cycle</td></tr>
<tr><td>6.</td><td>Academic year / semester /</td><td>First year / first semester</td><td>7.</td><td>Number of ECTS credits</td><td>6</td></tr>
<tr><td>8.</td><td>Teacher</td><td colspan="4">A group of professors engaged in the study program</td></tr>
<tr><td>9.</td><td>Prerequisites for enrolling in the course</td><td colspan="4">/</td></tr>
<tr><td>10.</td><td colspan="5">Course Objectives (Competencies):

The aim of the course is to prepare students for independent scientific research.
Upon successful completion of the course, students are expected to:
• understand the essence and significance of scientific research work;
• distinguish between different research methodologies in science;
• understand the process of formulating research problems, hypotheses, and their verification;
• understand the principles of concept formation and conceptual clarification;
• comprehend the role and significance of observation, experimentation, and statistical methods in research;
• differentiate between inductive and deductive approaches;
- systematically organize and logically structure a scientific discipline and research process.</td></tr>
<tr><td>11.</td><td colspan="5">Course Content:

The essence and significance of scientific research work; general assumptions of scientific inquiry.
Subject and methods of science; general, specific, and specialized methodologies.
Classical and contemporary methodological approaches: from methodological monism to methodological anarchism.
General process of scientific research: formulation of research problems, development of hypotheses, hypothesis verification, and problem-solving.
Methods for concept formation and conceptual clarification: analysis, synthesis, abstraction, generalization, and concretization.
Definition and classification of concepts.
Methods of establishing, substantiating, and proving scientific statements: observation, experimentation, and statistical methods.
Inductive methods.
Deductive methods.
Systematization and logical organization of research results: scientific discovery, scientific law, scientific theory, scientific system, and scientific discipline.</td></tr>
<tr><td>12.</td><td colspan="5">Teaching methods: Lectures supported by slide presentations, interactive lectures, practical exercises (using equipment and software packages), teamwork, case studies, invited guest</td></tr>
</table>

	lecturers, independent preparation and presentation of project assignments and seminar papers, and learning in an electronic environment (forums and consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project assignment	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of assessment				
	17.1.	Final Exam		40 points	
	17.2.	Individual work/project (presentation: written and oral)		50 points	
	17.3.	Activity and participation		10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)	
			51 x to 60 points	6 (six) (E)	
			61 x to 70 points	7 (seven) (D)	
			from 71 to 80 points	8 (eight) (C)	
			from 81 to 90 points	9 (nine) (B)	
			from 91 to 100 points	10 (ten) (A)	
19.	Requirement for signature and passing the final exam	Attendance at the Activities 15.1 and 15.2			
20.	Language of instruction	Macedonian and English			
21.	Method of monitoring the quality of teaching	In accordance with the university procedures and quality control methods			

22. Literature

22.1. Required literature

Ord. Number	Author	Title	Publisher	Year
1.	B. Roberts	Getting the Most Out of the Research Experience What Every Researcher Needs to Know	SAGE Publications	2007
2.	R. Phelps, K. Fisher, A. Ellis	Organizing and Managing, A Practical Guide for Postgraduates	SAGE Publications	2007

		3.	M. Alley	The Craft of Scientific Presentations Critical Steps to Succeed and Critical Errors to Avoid	Springer Verlag	2003
	22.2.	Additional literature				
		Serial Number	Author	Title	Publisher	Year
		1.				
		2.				
		3.				

1.	Title of the course	Scientific Research Methods and Academic Writing Skills for Papers and Projects			
2.	Code	CTI31M1			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	third cycle			
6.	Academic year / semester /	First year / first semester	7.	Number of ECTS credits	6
8.	Teacher	A group of professors engaged in the study program			
9.	Prerequisites for enrolling in the course	/			
10.	**Course Objectives (Competencies):** The aim of this course is to prepare doctoral students with the knowledge and skills required to conduct independent research and prepare scholarly reports, while fostering the transition from the application of existing knowledge toward the generation of original scientific and research contributions. Upon successful completion of the course, students will be able to: • understand the organization and structure of technical and scientific reports; • apply appropriate citation and referencing practices in technical and academic writing; • understand the process of developing engineering and scientific manuscripts, as well as the procedures involved in their publication; • comprehend the principles and practices of reviewing and evaluating technical and scientific reports; • critically assess the significance and impact of current scientific and applied publications within their field of study; • critically evaluate and review technical and scientific documents; • identify, access, and utilize relevant published literature through libraries, bibliographic databases, online search engines, and other scholarly resources; • prepare and deliver concise reviews and presentations of current research and published work in a selected scientific or technical domain.				
11.	**Course content:** Academic writing and scholarly communication. Quality assessment and review of				

	scientific work. Constructive criticism, organizational and ethical standards in research, citation and referencing practices, academic culture, student-centred learning, anti- discrimination principles, and equal opportunities in higher education. Overview of intellectual property rights and copyright regulations. Types and scope of scholarly publications. Literature search tools, indexing services, citation databases, bibliographic management, and citation analysis. Research processes and scientific research methodologies. Research funding opportunities and sources. Preparation of research proposals and project applications, evaluation of research proposals, and planning and management of research projects. Selection and dissemination of research results. Structure and preparation of scientific manuscripts. Peer-review and evaluation processes in scientific publishing. Preparation and presentation of conference papers and posters. Publication practices in academic and engineering journals. Literature reviews, critical reading and synthesis of relevant scientific literature, purpose and structure of review papers, and analysis of representative review articles. Research philosophy, including the epistemological, ontological, and methodological foundations of scientific inquiry.	
12.	Teaching methods: Lectures supported by slide presentations, interactive lectures, exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).	Teaching methods: Lectures supported by slide presentations, interactive lectures, practical exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent

					preparation and presentation of project assignments and seminar papers, and learning in an electronic environment (forums and consultations).
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of assessment				
	17.1.	Final Exam		40 points	
	17.2.	Seminar paper/project, written and oral presentation		50 points	
	17.3.	Activity and participation		10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)	
			51 x to 60 points	6 (six) (E)	
			61 x to 70 points	7 (seven) (D)	
			from 71 to 80 points	8 (eight) (C)	
			from 81 to 90 points	9 (nine) (B)	
			from 91 to 100 points	10 (ten) (A)	

19.	Requirement for signature and passing the final exam			Attendance at the Activities 15.1 and 15.2		
20.	Language of instruction			Macedonian and English		
21.	Method of monitoring the quality of teaching			In accordance with the university procedures and quality control methods		
22.	Literature					
	22.1.	Required literature				
		Ord. Number	Author	Title	Publisher	Year
		1.	B. Roberts	Getting the Most Out of the Research Experience What Every Researcher Needs to Know	SAGE Publications	2007
		2.	R. Phelps, K. Fisher, A. Ellis	Organizing and Managing, A Practical Guide for Postgraduates	SAGE Publications	2007
		3.	M. Alley	The Craft of Scientific Presentations Critical Steps to Succeed and Critical Errors to Avoid	Springer Verlag	2003
	22.2.	Additional literature				
		Serial Number	Author	Title	Publisher	Year
		1.				
		2.				
		3.				

<table>
<tr><td colspan="2">Attachment No. 3</td><td colspan="4">Course program of the third cycle of studies</td></tr>
<tr><td>1.</td><td>Title of the course</td><td colspan="4">Semantic Web</td></tr>
<tr><td>2.</td><td>Code</td><td colspan="4">CTI3xE0 8</td></tr>
<tr><td>3.</td><td>Study program</td><td colspan="4">Computer techniques and informatics</td></tr>
<tr><td>4.</td><td>Organizer of the study program (unit, i.e. institute, department, division)</td><td colspan="4">University of Information Sciences and Technologies "St. Paul the Apostle" - Ohrid;
Faculty of Computer Science and Engineering - FCSE</td></tr>
<tr><td>5.</td><td>Degree (first, second, third cycle)</td><td colspan="4">third cycle</td></tr>
<tr><td>6.</td><td>Academic year / semester /</td><td>First year / winter/summer</td><td>7.</td><td>Number of ECTS credits</td><td>7.5</td></tr>
<tr><td>8.</td><td>Teacher</td><td colspan="4">Assoc. Prof. Dr. Dijana Capeska Bogatinoska</td></tr>
<tr><td>9.</td><td>Prerequisites for enrolling in the course</td><td colspan="4">/</td></tr>
<tr><td>10.</td><td colspan="5">Objectives of the subject program (competencies):
This course covers the basic technical skills and competencies that need to be master in order to be able to use the Internet as a space for data exchange:
• in the section " Principles of the Web of Linked Data": students will learn the principles of publishing and retrieving data directly on /from the Internet instead of from websites ;
• in the section , "RDF Data Model": they will learn the standard Internet data model and its syntax for publishing and linking data on the Internet in your applications and services;
• in the "SPARQL Query Language" section: they will learn how to directly query and access data sources on the Internet and obtain structured data relevant to their activity and domain;
• In the final section , "Integrating Other Formats and Data Sources," they will learn how web standards interact and collaborate with other data formats to enable the integration of different data sources.</td></tr>
<tr><td>11.</td><td colspan="5">Course content:
1. Principles of the Web of Linked Data (Introduction to Web Architectures; Internet vs. Web; World Wide Web Consortium (W3C) Documents; Separation of Presentation and Content; XML Parsers; From Web Pages to Resources; Principles of Linked Data; Standards and Languages; Dbpedia; Web of Data Search Engines; Linked Data for Exploratory Search).
2. RDF data model (Truncal model and graph model; Values, types and languages; Naming graphs; RDF schema; Validating and translating RDF data; Visualizing RDF graphs).
3. SPARQL Query Language (RDF Graph Pattern Matching; Statements; Filter, Constraint and Function; Pre- and Post-processing; several query forms; Results and Update; Flint SPARQL editor; Corese; Gephi and Corese for web data analysis).
4. Integration of other formats and data sources (RDFa: RDF syntax in HTML; GRDDL: RDF from X(HT)ML; JSON-LD: JSON syntax for RDF; Tabular data and metadata (CSV); R2RML: database integration; LDP: REST API for linked data; Augmenting the web browser with data on pages; RDFa distiller; JSON-LD from Google Knowledge Graph API; Licentia: website to choose the license for your data;)</td></tr>
<tr><td>12.</td><td colspan="5">Learning methods: Lectures supported by slide presentations, interactive lectures, exercises (using equipment and software packages), teamwork, case studies, invited guest lecturers, independent</td></tr>
</table>

	preparation and defense of a project assignment and seminar work, learning in an electronic environment (forums, consultations).				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	45 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	5 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of assessment				
	17.1.	Tests		40 points	
	17.2.	Individual work/project (presentation: written and oral)		50 points	
	17.3.	Activity and participation		10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)	
			51 x to 60 points	6 (six) (E)	
			61 x to 70 points	7 (seven) (D)	
			from 71 to 80 points	8 (eight) (C)	
			from 81 to 90 points	9 (nine) (B)	
			from 91 to 100 points	10 (ten) (A)	
19.	Requirement for signature and passing the final exam		implemented activities 15.1 and 15.2		
20.	Language of instruction		Macedonian and English		
21.	Method of monitoring the quality of teaching		Monitoring UINT control procedures		
22.	Literature				
	22.1.	Required literature			
		Ord. Number	Author	Title	Publisher	Year

		1.	Aidan Hogan, Eva Blomqvist, Michael Cochez, Claudia D'Amato, Gerard de Melo, Claudio Gutierrez, Sabrina Kirrane, Jose Emilio Labra Gayo, Roberto Navigli, Sebastian Neumaier, Axel Cyrille Ngonga Ngomo, Axel Polleres, Sabbir M. Rashid, Anisa Rula, Lukas Schmelzeisen, John Sequeda, Stephen Staab, Anthony Zimmermann	Knowledge Graphs.	Morgan & Claypool	2021
		2.	Tom Heath, Christian Bizer	Linked Data: Evolving the Web into a Global Data Space.	Morgan & Claypool	2011
		3.	Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph	Foundations of Semantic Web Technologies	Chapman & Hall/CRC	2009
		4.	Grigoris Antoniou, Paul Groth, Frank van Harmelen, and Rinke Hoekstra	A Semantic Web Example.	MIT Press	2012
	22.2.	Additional literature				
		Serial Number	Author	Title	Publisher	Year
		1.	Dean Allemang, and James Hendler	Semantic Web for the Working Ontologist, Second Edition: Effective Modeling in RDFS and OWL	Morgan Kaufmann	2011

		2.	John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, and Mike Dean	Semantic Web Programming	Wiley	2009
		3.	David Wood, Marsha Zaidman, Luke Ruth, and Michael Hausenblas	Linked Data: Structured Data on the Web	Manning Publications	2014
		4.	Bob DuCharme	Learning SPARQL Querying and Updating with SPARQL 1.1	O'Reilly Media	2013
		5.	Web Toby Segaran, Colin Evans, and Jamie Taylor	Programming the Semantic Web, Build Flexible Applications with Graph Data	O'Reilly Media	2009

Прилог бр.3		**Предметна програма од третиот циклус на студии**			
1.	Title of the teaching subject	Statistical Data Analytics			
2.	Code	CTI3xE19			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	third cycle			
6.	Academic year / semester	Second year / fourth semester	7.	ECTS	7,5
8.	Teacher	Prof. Elena Hadzieva, PhD			
9.	Prerequisites for Attending the Course	Mathematics 1, Mathematics 2, Linear Algebra, Probability and Statistics			
10.	**Course Objectives (Competencies):** Students will be able to perform more thorough and comprehensive data analysis using concepts from statistics. They will acquire the skills necessary to apply supervised and unsupervised learning techniques for making predictions and supporting decision-making processes. The course will address practical problems arising from real-world situations, enabling students to make informed decisions in project management. In addition, students will work on research-oriented project assignments that require a more analytical approach. Students will learn a wide range of supervised and unsupervised learning techniques and will be able to analyze and compare their performance and outcomes. Practical problem-solving and implementation will be carried out using Python.				
11.	**Course Content:** Introduction to Data Analytics. Fundamentals of probability and statistics for data analytics. Concepts and techniques of unsupervised learning. Simple linear regression. Weighted linear regression. Multiple linear regression. Matrix formulation of linear regression. Polynomial regression. Feature selection. Concepts and techniques of supervised learning. Extended linear regression models. Classification. Binary classification using linear regression. Discriminant analysis. Tree-based methods. Dimensionality reduction. Principal Component Analysis (PCA). Hierarchical and partitional clustering.				
12.	Interactive teaching – 45 hours and interactive tutorials – 30 hours, individual work through homework and projects.				
13.	Total Available Time Allocation	120 hours			
14.	Distribution of Available Time	45 + 5 + 30 + 15 + 25 = 120 hours			
15.	Forms of Teaching Activities	15.1.	Lectures – theoretical instruction	45 hours	
		15.2.	Exercises (laboratory, auditory), seminars, teamwork	5 hours	
16.	Other forms of activities	16.1.	Project Assignments	30 hours	
		16.2.	Independent Assignments	15 hours	
		16.3.	Home Learning – Assignments	25 hours	
17.	Assessment Method				
	17.1.	Final Exam		50 points	

	17.2.	Seminar paper/project, written and oral presentation		40 points
	17.3.	Activity and Participation		10 points
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F)
			from 51 to 60 points	6 (six) (E)
			from 61 to 70 points	7 (seven) (D)
			from 71 to 80 points	8 (eight) (C)
			from 81 to 90 points	9 (nine) (B)
			from 91 to 100 points	10 (ten) (A)
19.	Requirements for Signature and Taking the Final Exam	Attendance at the Activities 15.1 and 15.2		
20.	Language of Instruction	Macedonian and English		
21.	Method for monitoring the quality of teaching	In accordance with the university procedures and quality control methods		

22. Literature

22.1. Mandatory Literature

No.	Author	Title	Publisher	Year
1.	Walter W. Piegorsch	Statistical Data Analytics	Wiley	2015
2.	Mohammed M. Alani, Hissam Tawfik, Mohammed Saeed, Obina Anya (Eds)	Applications of Big Data Analytics, Trends, Issues, and Challenges	Springer	2018
3.				

22.2. Additional Literature

No.	Author	Title	Publisher	Year
1.	Peter Bruce, Andrew Bruce	Practical Statistics for Data scientists	O'Reilly Media, Inc.	2017
2.	William McKinney	Python for Data analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd edition	O'Reilly Media	2017
3.				

Annex no. 3		**Course program of the third cycle of studies**			
1.	Title of the course	Stochastic models in information and communication technologies			
2.	Code	CTI3xE21			
3.	Study program	Computer Techniques and Informatics			
4.	Organizer of the study program (unit, i.e. institute, department, division)	UIST, Faculty of computer sciences and engineering			
5.	Degree (first, second, third cycle)	Third cycle			
6.	Academic year / semester /	First year / winter/summer	7.	Number of ECTS credits	7.5
8.	Teacher	Prof. Dr. Ninoslav Marina			
9.	Prerequisites for attending the course	/			
10.	Objectives of the subject program (competencies): To introduce students to stochastic models and their use in information and communication technologies				
11.	Course content: In this course, students will be introduced to advanced stochastic models that can be used in various areas of information science and technology. The course contains topics from probability theory that will be covered theoretically and with practical exercises in Python.				
12.	Teaching methods: The course is based on 40 hours of lectures and 10 hours of laboratory exercises in Python . There will also be a project assignment, independent work assignments, and homework required.				
13.	Total available fund on time	120 hours			
14.	Allocation of available time	40 + 10 + 30 + 15 + 25 = 120 hours			
15.	Forms of teaching activities	15.1.	Lectures - theoretical teaching .	40 hours	
		15.2.	Exercises (laboratory, classroom), seminars, teamwork.	10 hours	
16.	Other forms of activities	16.1.	Project tasks	30 hours	
		16.2.	Independent tasks	15 hours	
		16.3.	Homework – assignments	25 hours	
17.	Method of assessment				
	17.1.	Final Exam		40 points	
	17.2.	Seminar paper/project, written and oral presentation		50 points	
	17.3.	Activity and Participation		10 points	
18.	Assessment criteria (points/grade)		up to 50 points	5 (five) (F) 5 (five) (F)	
			51 x to 60 points	6 (six) (E) 6 (six) (E)	
			61 x to 70 points	7 (seven) (D)	

					7 (seven) (D)	
				from 71 to 80 points	8 (eight) (C) 8 (eight) (C)	
				from 81 to 90 points	9 (nine) (B) 9 (nine) (B)	
				from 91 to 100 points	10 (ten) (A) 10 (ten) (A)	
19.	Requirement for signature and passing the final exam			Attendance at the Activities 15.1 and 15.2		
20.	Language of instruction			Macedonian and English		
21.	Method of monitoring the quality of teaching			In accordance with the university procedures and quality control methods		
22.	Literature					
	22.1.	Mandatory literature				
		Ord. Number /	Author	Title	Publisher	Year
		1.	M. Pinsky, S. Karlin	An Introduction to Stochastic Modeling	Academic Press	2010
		2.	A. Shiryaev, D. Chibisov	Probability 1	Springer	2016
		3.	S. Ross	Introduction to Probability and Statistics for Engineers and Scientists	Academic Press	2020
	22.2.	Additional literature				
		Order No.	Author	Title	Publisher	Year
		1.	W. Feller	An Introduction to Probability Theory and Its Applications, Vol. 1	Wiley	1968
		2.	W. Feller	An Introduction to Probability Theory and Its Applications, Vol. 2	Wiley	1971
		3.	P. Bremaud	Discrete Probability Models and Methods: Probability on Graphs and Trees, Markov Chains and Random Fields, Entropy and Coding	Springer	2017