ISMA
ANNO 1994

ISMA Course Catalogue 2024/2025 for International (Erasmus+) Students

Master of Computer Systems

Please note some subject`s names, ECTS and codes may be changed during the study year.

Student can choose any subject from Autumn Semester or any subject from Spring Semester, depends on which semester student is going to study in ISMA.

Master students in order to expand their course can get an individual plan of studies and to join courses delivered for Bachelor students. In this case these elected subjects will also be reflected at a Transcript of Records. Orientation meeting with ISMA coordinator is compulsory.

ISMA will inform the student about possible changes and according alternatives will be offered. Changes in Learning Agreement will be done then. ISMA International Relations department karina.lazareva@isma.lv and erasmus@isma.lv

2024/2025 st.year		
Course Code	**Course Name ENG**	**ECTS**
MA0331	Machine Learning Algorithms	6
IN1243	Big Data Architectures	6
IN1244	Introduction to Quantum Computing	3
IN0686	WEB Application Security Fundamentals	3
MA0329	Mathematics for System Analysts	6
IN4003	System Approach to Computer System Design	6
IN0695	Programming for Data Science	9
IN1242	Databases and SQL	3
IN0697	Data Analysis	3

ISMA study course Machine Learning Algorithms

Study program	Computer Systems
ECTS	6
Author (s)	Andrejs Bondarenko, Dr. Comp. Sc. docent, Department of Natural Science and Computer Technology
Preliminary knowledge, Related study courses	Algorithms and Data Structures
Aim	To provide students with a deep understanding of artificial neural networks and their applications. Students will learn how to implement and evaluate neural network models using appropriate software and tools such as Keras and PyTorch. They will also gain knowledge of other machine learning algorithms and learn when to choose these algorithms over neural networks. Upon completion of this course, students will be able to develop and apply artificial neural networks to solve real-world problems and choose the appropriate algorithm for a given task.
Planned learning outcomes	
Knowledge	1. Understanding of the theoretical foundations of feedforward neural networks, convolutional neural networks, and their applications. 2. Knowledge of other machine learning algorithms, such as linear regression, logistic regression, and decision trees. 3. Knowledge of backpropagation, regularization, optimization techniques, and transfer learning.
Skills	1. Ability to design and implement neural network models using appropriate software and tools, such as TensorFlow and Keras. 2. Ability to critically evaluate the results of machine learning models, including neural networks, and make informed decisions about model selection and deployment.
Competencies	1. Ability to make informed decisions about machine learning algorithms and technologies to support data-driven decision-making within an organization. 2. Ability to communicate machine learning concepts and results to stakeholders with varying levels of technical knowledge.
Literature and other sources of information:	
• Compulsory reading	1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, Aurélien Géron, O'Reilly Media, 2019. 2. Mastering Machine Learning Algorithms: Expert techniques for implementing popular machine learning algorithms, fine-tuning your models, and

	understanding how they work, 2nd Edition by Giuseppe Bonaccorso 2020 3. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016. 4. Deep Learning for Coders with fastai and PyTorch: AI Applications Without a PhD, Jeremy Howard and Sylvain Gugger, 2020. 5. The Elements of Statistical Learning Data Mining, Inference, and Prediction (2nd ed., 12th printing), Trevor Hastie, Robert Tibshirani, Jerome Friedman, 2017.
● Recommended	1. The Hundred-Page Machine Learning Book, Andriy Burkov, 2019. 2. Designing Machine Learning Systems, Chip Huyen, O'Reilly Media, 2022. 3. Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, 2018.

Study course content and schedule of contact hours

Week	Topic	Type of training	Academic hours	
			full-time	**part-time intramural**
1	1	Introduction to Machine Learning and Neural Networks ● Overview of machine learning and its applications ● Introduction to neural networks and their history ● Types of neural networks	3	2
2	2	Linear Regression ● Introduction to linear regression ● Understanding the assumptions of linear regression ● Optimization techniques for linear regression	3	2
3	3	Logistic Regression ● Introduction to logistic regression ● Understanding the assumptions of logistic regression ● Optimization techniques for logistic regression	3	2
4	4	Fundamentals of Feedforward Neural Networks ● Basic architecture of a feedforward neural network ● Activation functions and their properties ● Forward propagation and output computation	3	2
5	5	Backpropagation and Gradient Descent ● The concept of error and loss function ● Backpropagation algorithm for weight updates ● Gradient descent optimization and its variants	3	2

5	6	Overfitting, Regularization and Early Stopping ● Understanding overfitting and its causes ● Regularization techniques such as L1, L2, and dropout ● Early stopping as a way to prevent overfitting	3	2
7	7	Decision Trees ● Introduction to decision trees ● Recursive partitioning algorithm ● Criteria for selecting optimal splits	3	2
8	8	Random Forests ● Introduction to random forests ● Advantages and disadvantages of random forests ● Random forests for feature selection	3	2
9	9	Convolutional Neural Networks (CNNs) ● Introduction to convolutional neural networks ● Architecture and components of CNNs ● Applications of CNNs in computer vision tasks	3	2
10	10	Recurrent Neural Networks (RNNs) ● Introduction to recurrent neural networks ● Architecture and components of RNNs ● Applications of RNNs in natural language processing and time series analysis	3	2
11	11	Long Short-Term Memory (LSTM) Networks ● The limitations of classical RNNs ● Introduction to LSTM networks ● Applications of LSTM in sequence modeling and prediction	3	2
12	12	Autoencoders and Unsupervised Learning ● Introduction to autoencoders ● Unsupervised learning using autoencoders ● Applications of autoencoders in dimensionality reduction and data compression	3	2
13	13	Transfer Learning and Fine-Tuning ● Introduction to transfer learning ● Fine-tuning pre-trained models for new tasks ● Applications of transfer learning in various domains	3	2
14	14	Keras and PyTorch ● Introduction to PyTorch and Keras ● Building neural network models using PyTorch and Keras ● Visualization and interpretation of neural network models using Tensorboard	3	2
15	15	Interpretability and Explainability in ML and Neural Networks ● Interpretability and explainability in ML algorithms (non-ANN) ● Methods for interpreting neural network models	3	2
16	16	Case Studies and Applications	3	2

		• Case studies of neural networks in various domains such as healthcare, finance, and entertainment • Discussion of ethical considerations in the use of neural networks • Future directions and challenges in the field of neural networks		
		Total:	48 ac.h	32 ac.h

Description of students' self-studies organisation and assignments

Self-study work	**Ac.hours for full-time/ part-time intramural/ distance studies extramural**	**Planned learning outcomes**
1. Compulsory reading, sources, and methodological materials learning	24/32/40	Knowledge, Skills, and Competencies: Students studied the core concepts of machine learning principles.
2. Familiarization with supervised learning techniques.	24/32/40	Knowledge, Skills, and Competencies: Students demonstrate knowledge of supervised learning and algorithms implementing classification and regression problems.
3. Familiarization with unsupervised learning techniques, model selection, and ensemble methods.	24/32/40	Knowledge, Skills, and Competencies: Students demonstrate their knowledge of the unsupervised algorithms as well as models selection and result interpretation; additionally demonstrate knowledge of ensemble models..
4. Practical Exercises	24/32/40	Knowledge, Skills, and Competencies: Students can set up a machine learning project, prepare data, train models, assess their performance, and present the results.
Total:	112/128/160	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**

1. Home works (Self-study work)	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	**Requirements**
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 –very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient understanding of some main concepts is detected as well as considerable difficulties in the practical application of the acquired knowledge are stated;
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.

ISMA study course Big Data Architecture

Study programme	Computer Systems
ECTS	6
Preliminary knowledge, Related study courses	Algorithms and Data Structures, Data Modelling, Databases and Database Management Systems, SQL.
Aim	The course aims at describing the big data processing framework, both in terms of methodologies and technologies. The course is focused on the relevant architecture of Big Data Systems, their building, implementation and management. The course emphasizes the skills and knowledge to identify and communicate business system needs, to develop right Big Data system architecture and software/hardware infrastructure and implement it into organizations to improve business performance and get profit from available data.
Planned learning outcomes	
Knowledge	
	1. Big Data frameworks. - Mining of Big Data. - Processing of data streams. - Analysis of time series. - Recommender systems. - Analysis of social networks.
Skills	
	1. Understand important aspects of Big Data. 2. Ability to apply acquired knowledge for understanding data and select suitable methods for processing and analyzing Big Data.
Competencies	
	Apply Big Data related technologies in developing applications to solve common problems faced by organisations.
Literature and other sources of information:	
● Compulsory reading	1. Saurabh Shrivastava, Solutions Architect's Handbook: Kick-start your career as a solutions architect by learning architecture design principles and strategies, 2nd Edition, March 21, 2020, 490 pages, ISBN- 978-1838645649. 2. Modern Big Data Architectures: A Multi-Agent Systems Perspective 1st Edition by Dominik Ryzko, 2020 3. Dipanker Jyoti, James A. Hutcherson,| Salesforce Architect's Handbook: A Comprehensive End-to-End Solutions Guide 1st ed., Jan 21, 2021, ISBN - 978-1484266304. 4. Dominik Ryzko, Modern Big Data Architectures,March 2020, Publisher(s): Wiley, ISBN: 9781119597841
● Recommended	1. Francesco Corea , An Introduction to Data: Everything You Need to Know About AI, Big Data and Data Science, Series: Studies in Big Data №50, Publisher: Springer, 2019, ISBN: 9783030044671 2. Phillips-Wren, Gloria; McKniff, Sueanne, Overcoming Resistance to Big Data and Operational Changes Through

	Interactive Data Visualization, Series: Big Data 2020-dec 01 vol. 8 iss. 6, 2020 3. Sherif Sakr, Albert Y. Zomaya, Encyclopedia of Big Data Technologies, 2019.

Study course content and schedule of contact hours

Week	Topic	Academic hours	
		full-time	**Part-Time intramural**
1	Introduction. What is Big Data Architecture? Definiton of Big Data Architecture. Evolution of Big Data Architecture	6	4
2	Big Data Architecture and Its Sources Big Data Platforms Big Data Architecture Use Cases	6	4
3	Big Data and Its Technical Challenges Typical Big Data system architecture and Big Data instruments Storage techniques. Databases Hadoop Distributed File System Hadoop essentials Hadoop ecosystem Architecture principles for realtime Big Data systems Big Data Systems implementation Management of Big Data Systems	6	4
4	NOSQL Database Systems	6	4
5	Data Streams	6	4
6	Big Data Analysis and Technologies	6	4
7	Introducing Apache Spark Spark Component/Tools and In Depth Study RDDs, Spark SQL	6	4
8	Data visualization & ML: Apache Spark (+ Zeppelin + Vegas/Helium as libraries for visualization) End2End use case	6	4
	Total	48 ac.h	32 ac.h

Description of students' self-studies organisation and assignments

Self-study work	Ac.hours for full-time/ Part-Time intramural/ Part-Time extramural	Planned learning outcomes
Lambda Architecture	56/64/80	Knowledge, Skills and Competencies: Explain and compare the architecture of contemporary Big Data tools and platform
Kappa Architecture	56/64/80	Knowledge, Skills and Competencies: Explain and compare the architecture of contemporary Big Data tools and platform
Total:	112/128/160	

Study work	Knowledge	Skills	Competences	% of final evaluation
1. Home works (Self-study work)	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	Requirements
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 –very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient

	understanding of some main concepts is detected as well as considerable difficulties in the practical application of the acquired knowledge are stated;
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.

ISMA study course Introduction to Quantum Computing

Study programme	Computer Systems
ECTS	6
Preliminary knowledge, Related study courses	Mathematics for System Analytics
Aim	The purpose of the course is to acquaint students with the basic ideas and main operations and algorithms in Quantum Computing.
Planned learning outcomes	
Knowledge	
	1. Understand the difference between classical and quantum computing. 2. Understand the mathematical description of quantum states and basic quantum operations. 3. Understand the quantum logic and algorithms and programming ideas.
Skills	
	1. Be able to explain and compare the difference between classical and quantum computing. 2. Be able to perform basic quantum computing operations 3. Be able to understand and use the concepts of qubits in quantum gates. 4. Be able to explain the basic structure of quantum algorithms. 5. Be able to understand the simplest quantum programs.
Competencies	
	1. Understand the benefits of quantum computing 2. Understand the basics quantum computing operations and algorithms. 3. Initial understanding of quantum programming languages.
Literature and other sources of information:	
• Compulsory reading	1. Quantum Computing for Everyone. Chris Bernhard. MIT Press (March 19,2019), 214 pages, ISBN: 0262539535 2. Quantum Computing Fundamentals 1st Edition by Easttom II r (2021) 3. A First Introduction to Quantum Computing and Information. Bernard Zygelman. Springer; 1st ed. 2018 edition (October 4, 2018), 250 pages, ISBN-10: 3319916289
• Recommended	1. Ciaran Hughes, Joshua Isaacson. Quantum Computing for the Quantum Curious. Springer; 1st ed. 2021 edition (March 22, 2021) 202 pages 2. Introduction to Classical and Quantum Computing Thomas G. Wong https://www.thomaswong.net/ 3. **Quantum Country by A. Matuschack and M. Nielsen** https://quantum.country/

Study course content and schedule of contact hours

Week	Topic	Academic hours	
		full-time	**Part-Time intramural**

1	Historical aspects of quantum computing. Linear algebra review for quantum computing. Inner product, vector transformations, Unitary matrices, tensor product, bra-ket notation.	6	4
2	Basics of quantum mechanics for quantum computing: postulates, interference, measurement, superposition, entanglement.	6	4
3	Qubits and quantum states	6	4
4	Classical and quantum logic gates and circuits.	6	4
5	Quantum operations	6	4
6	Simple quantum algorithms. Factoring (Shor) and search (Grover) algorithms	6	4
7	Cryptography classical and quantum. Teleportation.	6	4
8	Introduction to quantum programming.	6	4
	Total	48 ac.h	32 ac.h

Description of students' self-studies organization and assignments

Self-study work	**Ac hours for full-time/ Part-Time intramural/ Part-Time extramural**	**Planned learning outcomes**
Quantum computing operations.	56/64/80	Knowledge, Skills and Competencies: skills to make and understand quantum operations
Quantum logic, algorithms and circles and realization	56/64/80	Knowledge, Skills and Competencies: understanding and realization of quantum algorithms
Total:	112/128/160	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**
1. Home works (Self-study work)	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	**Requirements**
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 –very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient understanding of some main concepts is detected as well as considerable difficulties in the practical application of the acquired knowledge are stated;
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.

ISMA study course Web Application Security Fundamentals

Study programme	Computer Systems
ECTS	3
Preliminary knowledge, Related study courses	Computer Security Principles and Technologies, Web technology fundamentals
Aim	To help understanding security testing standards, methodologies and tools To provide an insight into web application protocols To teach the approaches to penetration testing To make sure that skills in security testing of web applications are acquired
Planned learning outcomes	
Knowledge	
	1. Fundamental concepts of web application technologies. 2. Fundamental concepts of web application architectures. 3. Understanding of web application related threats and protection controls.
Skills	
	1. Ability to understand type of architecture and technologies used 2. Ability to perform reconnaissance and collect information about test environment 3. Ability to select the required tests based on standards and best practices
Competencies	
	1. The ability to apply the theoretical and practical knowledge and skills for the basic web application security assessment 2. The ability to work individually and in a team, applying their knowledge, being able to take responsibility for the results of their performance 3. The ability to set up security requirements in relation to Web Functionality, web protocols, type of encoding, authentication & authorization.
Literature and other sources of information:	
Compulsory reading	1. PCI SSC penetration testing guidance, https://listings.pcisecuritystandards.org/documents/Penetration-Testing-Guidance-v1_1.pdf 2. PTES methodology, http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines 3. Web Application Security: Exploitation and Countermeasures for Modern Web Applications 1st Edition by Andrew Hoffman, 2020 4. OWASP testing guide v4 (Web Application Penetration Testing), https://www.owasp.org/images/1/19/OTGv4.pdf

Recommended	1. Dafydd Stuttard, Marcus Pinto. The Web Application Hacker's Handbook – Finding and Exploiting Security Flaws, Second edition. John Wiley & Sons, Inc. 2011. – 914p.Network+: Guide to Networks

Study course content and schedule of contact hours

Week	Topic	Academic hours	
		full-time	**Part-Time intramural**
1.	Introduction to WEB Technologies.	4	2
2.	Web Architecture	4	2
3.	Web Functionality	4	4
4.	HTTP protocol	4	4
5.	Encoding Schemes	4	2
6.	Authentication, Cookies and Sessions	4	2
	Total	24 ac.h	16 ac.h

Description of students' self-studies organisation and assignments

Self-study work	**Ac.hours for full-time/ Part-Time intramural/ Part-Time extramural**	**Planned learning outcomes**
1. Introduction. Compulsory reading, sources and methodological materials learning	8/8/12	Knowledge, Skills and Competencies: Students studied the problems of Web technology fundamentals, web architecture and reference designs, basic security requirements.
2. Evolution of Web Application Security. Alternative way of viewing page source code. Find sensitive Hyperlinks. Find JavaScript in source code. Client-side technologies.	12/16/16	Knowledge, Skills and Competencies: Students understand how to view page source code, how to identify Content Management System that is used
3. Server-side technologies. HTTP Protocol. Observe network connections. Show Client-Server Flow History. Verify HTTP Request Methods.	12/16/16	Knowledge, Skills and Competencies: Students understand how to Find sensitive Hyperlinks, how to find JavaScript in source code, to distinguish between Client-side technologies and Server-side technologies
4. Examine URL HTTP Response Status Codes	8/8/12	Knowledge, Skills and Competencies: Students understand how to review

HTTP Headers Security HTTP Headers		HTTP Protocol activities, how to observe network connections, how to view Client-Server Flow History, how to verify HTTP Request Methods
5. Subdomains and HTTPS. TLS Certificates. TLS Certificate formats. TLS Multi domain Certificates. Cipher Suites.	8/8/12	Knowledge, Skills and Competencies: Students understand how to examine URL addresses, what HTTP Response Status Codes mean, how to study HTTP Headers – Requests and Responses, investigate Security HTTP Headers, how DNS system operates, how to observe TLS Certificates contents, how to select secure protocols in Cipher Suites, how HTTPS protocol.
6. Encoding. HTTP Cookies. Sessions. Authentication.	8/8/12	Knowledge, Skills and Competencies: Students understand how to perform simple types of encoding, how to decode the encoded message, how to identify session parameter manipulation, how to ensure proper authentication type selection.
Total:	56/64/80	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**
1. Home works	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	**Requirements**
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;

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ISMA study course Mathematics for System Analysts

Study programme	Computer Systems
ECTS	6
Preliminary knowledge, Related study courses	Mathematics, Mathematical methods,
Aim	The purpose of the course is - to study the conceptual apparatus of the discipline, the main theoretical provisions and methods, the formation of skills and instilling skills in applying theoretical knowledge to solve applied problems; - to acquaint students with the basics of knowledge management and the features of processing various types of data; - to provide understanding and skills in the use of appropriate analytical methods and tools to effectively create, extract, maintain, recover and disseminate data and knowledge that is useful for business.
Planned learning outcomes	
Knowledge	
	1. Methods of analysis, pre-processing and statistical description of data 2. Direct and iterative methods for solving systems of linear equations. 3. Basic methods for solving nonlinear equations and their systems 4. Numerical methods for solving ordinary differential equations;
Skills	
	1. Apply methods of analysis, pre-processing and statistical description of data 2. Apply direct and iterative methods for solving systems of nonlinear equations in solving applied problems. 3. Apply methods for solving nonlinear equations in solving applied problems. 4. Apply numerical methods for solving ordinary differential equations in solving applied tasks.
Competencies	
	1. Programming skills of numerical methods in mathematical software packages. 2. Analyse socio-economic tasks and processes using the methods of system analysis and mathematical modelling 3. Justify the choice of design solutions for the types of information systems support 4. Apply a systematic approach and mathematical methods in formalizing the solution of applied problems
Literature and other sources of information:	
• Compulsory reading	1. Data science and AI in FinTech: an overview, Cao, Longbinga, Yang, Qiangb, Yu, Philip S., 2021, International Journal of Data Science and Analytics, Volume 12, Issue 2, Pages 81 – 99.

	2. Applied data analytics - principles and applications, Agbinya, Johnson I., River Publishers, 2020, 978-877022096-5, 978-877022095-8, pages 336 3. Using applied mathematical models for business transformation, Trad, Antoine, Kalpić, Damir, 2019, IGI Global 78-179981011-7, 978-179981009-4, 4. An introduction to numerical methods and analysis, Epperson, James F., 2021, Wiley publisher, ISBN 978-111960475-4, 978-111960469-3, pages 650. 5. Data Mining, 4th Ed., Ian H. Witten, Eibe Frank, Mark A. Hall, Christopher Pal, 2016 (3rd Ed.2011).
• Recommended	1. Python Programming: and Introduction to Computer Science, John M. Zelle, Preliminary Second Edition Fall, 2009. 2. Advanced Guide to Python 3 Programming, John Hunt, 2019, Springer Nature Switzerland, ISSN 1863-7310 3. Learning the Impact of Data Pre-processing in Data Analysis, 2018, Besim Bilalli, Universitat Politècnica De Catalunya, Department of Service and Information System Engineering, Barcelona, 2018 4. Data Mining and Machine Learning: Fundamental Concepts and Algorithms, 2nd Ed., Mohammed J. Zaki and Wagner Meira, Jr, 2020 (online book: https:// dataminingbook.info/book_html/). 5. An Introduction to Statistical Methods and Data Analysis, 2001, Fifth Edition, R. Lyman Ott, Thomson Learning Academic Resource Center, DUXBURY, ISBN 0-534-25122-6

Study course content and schedule of contact hours

Week	Topic	Academic hours	
		FT	**PT**
1	Introduction Variables and Basic Data Structures. Functions. Data structure. String. List. Tuple. Set. Arrays. Function basics. Local variables and global variables. Nested functions. Lambda functions. Functions as arguments to functions. Recursive functions. Branching statements. Iteration. Data objects and attribute types. Data transformation and data discretization. Normalization. Binning. Histogram analysis. Discretization by cluster, decision tree, and correlation analyses. Metadata	2	2
2	Statistical description of data Organizing and Producing Data. Displaying Data. Describing Distributions with Numbers. Correlation and Regression. Producing Data.	4	2
3	Probability. The basics of probability. Conditional probability and independence. Random variables and distribution functions. The expected value. Examples of mass functions and densities. The law of large numbers. The central limit theorem.	4	2

	Estimation Overview of estimation. Method of moments. Unbiased estimation. Maximum likelihood estimation. Interval estimation. Hypothesis testing. Simple hypotheses. Composite hypotheses. Extensions on the likelihood ratio. T procedures. Goodness of fit. Analysis of variance.		
4	Data pre-processing. Data quality. Data cleaning. Missing value. Noisy data. Data cleaning as a process. Data integration. Redundancy and correlation analysis. Tuple duplication. Data value conflict detection and resolution. Data reduction. Wavelet transforms. Principal components analysis. Attribute subset selection. Regression and log-linear models. Histograms. Clustering. Sampling. Data cube aggregation. Data classification. Cluster analysis. Outlier detection.	2	2
5	Linear Algebra and Systems of Linear Equations Basics of linear algebra. Sets. Vector. Matrices. Linear transformations. Systems of linear equations. Solutions to systems of linear equations. Gauss elimination method. Gauss-Jordan elimination method. LU decomposition method. Iterative methods – Gauss-Seidel method. Eigenvalues and Eigenvectors. Problem Statement Eigenvalues and eigenvectors. The motivation behind eigenvalues and eigenvectors. The characteristic equation. The power method. The QR method.	4	2
6	Regression Least squares regression problem statement. Least squares regression derivation. Linear algebra. Least squares regression derivation. Multivariate calculus. Least squares regression for nonlinear functions. Polynomial regression. Interpolation Interpolation problem statement. Linear interpolation. Lagrange polynomial interpolation. Newton's polynomial interpolation. Taylor Series Expressing functions using a Taylor series. Approximations using Taylor series. Discussion about errors. Truncation errors for Taylor series. Estimating truncation errors. Round-off errors for Taylor series.	4	2
7	Numerical differentiation. Numerical integration. Root finding. Ordinary differential equations initial value problems. Boundary-value problems for ordinary differential equations. Numerical error and Instability. Fourier transform.	4	2

8	Data visualization and plotting	2	2
9	Computer Experiments in the Python environment. Data structure. Tuple. Dictionary. Operators. Arrays. 2D Arrays.	4	2
10	Computer Experiments in the Python environment. Statistical description of data	2	2
11	Computer Experiments in the Python environment. Probability Functions and Empirical Distributions	2	2
12	Computer Experiments in the Python environment. Data classification. Cluster analysis. Outlier detection.	4	2
13	Computer Experiments in the Python environment. The Transpose of Vectors and Matrices, the Identity Matrix. Eigenvalues and Eigenvectors.	2	2
14	Computer Experiments in the Python environment. Taylor series. Interpolation.	2	2
15	Computer Experiments in the Python environment. Ordinary Differential Equations.	2	2
16	Computer Experiments in the Python environment. Data visualization.	4	2
	Total	48 ac. h	32 ac. h

Description of students' self-studies organisation and assignments

Self-study work	**Ac. hours for full-time/ Part-Time intramural/ Part-Time extramural**	**Planned learning outcomes**
Data pre-processing algorithms. Data classification. Cluster analysis. Outlier detection.	28/32/40	Knowledge, Skills and Competencies in the Python environment
Eigenvalues and Eigenvectors.	28/32/40	Knowledge, Skills and Competencies in the Python environment
Expressing functions using a Taylor series. Round-off errors for Taylor series.	28/32/40	Knowledge, Skills and Competencies in the Python environment
Data visualization algorithms	28/32/40	Knowledge, Skills and Competencies in the Python environment
Total:	112/128/160	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**
1. Home works (Self-study work)	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	**Requirements**
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 – very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient understanding of some main concepts is detected as well as considerable difficulties in the practical application of the acquired knowledge are stated;
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.

ISMA study course System Approach to Computer System Design

Study programme	Computer Systems
ECTS	6
Preliminary knowledge, Related study courses	Mathematics for System Analytics, Programming for Data Science and System Analytics, Computer Experiments and Modelling Technologies
Aim	Develop knowledge in order to determines measures of efficiency for development of skills in design of management systems. Summarize the knowledge to demonstrate effective decision making logic at any level of the organization and obtain insight into a system that provides hazard identification, analyse complex situations and develop activities for effective management actions, which are necessary for grow and producing.
Planned learning outcomes	
Knowledge	
	1. Understand the similarities and differences in management system design methodology. 2. Familiarity with high-level solutions and capabilities in the modern technologies to design management systems.
Skills	
	1. Be able to conduct a comprehensive functional-structural assessment of system's organisation 2. To use the main approaches and recommend suitable solutions, connecting the possibilities and needs of the problem area with available solutions. 3. To be able to analyse processes in the environment and make decisions according to the changes in the situation
Competencies	
	1. Understand the role of strategic and development plans for efficient management of the company. 2. To be able to summarise and critically assess the results of designing and implementing management systems, in turn being able to identify and formulate actual problems.
Literature and other sources of information:	
• Compulsory reading	1. Collins C., Dennehy D., Conboy K., Mikalef P. (2021) Artificial intelligence in information systems research: A systematic literature review and research agenda. https://doi.org/10.1016/j.ijinfomgt.2021.102383 International Journal of Information Management Volume 60, October 2021, 102383 2. Kossiakoff A., Swee N, Seymor S., Bier S. Systems Engineering Principles and Practice. John Willey & Sons, 2011. 3. Senge P., The Fifth Discipline: The Art and Practice of Learning Organization. Paperback, 2006.

• Recommended	○ Aulet B. Disciplined Entrepreneurship Workbook, 2017. ○ Business Analytics: Data Analysis and Decision Making, 7th Ed., S. Christian Albright, Wayne L. Winston, 2020. ○ Fred R. David. Strategic Management Concepts and Cases A Competitive Advantage Approach: 15th Edition, by Fred R. David and Forest R. David, published by Pearson Education, 2015 ○ Trompenaars F., Coebergh P.H. 100+ Management Models. How to understand and apply the world's most powerful business tool. – Oxford: Infinite Ideas Limited, 2014.

Study course content and schedule of contact hours

Week	Topic	Academic hours	
		full-time	**Part-Time intramural**
1	Introduction to efficient management methodology.	6	4
2	Applying the Vision Model to System Design	6	4
3	Business data collection	6	4
4	Assessment of management system efficiency.	6	4
5	System design procedure.	6	4
6	Dynamic methods for assessment of system efficiency.	6	4
7	System stability upon uncertainties.	6	4
8	Creating systemic thinking during design of systems.	6	4
	Total	48 ac.h	32 ac.h

Description of students' self-studies organisation and assignments

Self-study work	**Ac.hours for full-time/ Part-Time intramural/ Part-Time extramural**	**Planned learning outcomes**
System Design Algorithm	56/64/80	Knowledge, Skills and Competencies: give an understanding General Rules for Designing High Quality Systems.
System Design products	56/64/80	Knowledge, Skills and Competencies: create a system tool.
Total:	112/128/160	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**

1. Home works (Self-study work)	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	Requirements
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 – very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient understanding of some main concepts is detected as well as considerable difficulties in the practical application of the acquired knowledge are stated
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.

ISMA study course Programming for Data Science

Study programme	Computer Systems
ECTS	6
Preliminary knowledge, Related study courses	Python programming Mathematics (differential and integral calculus)
Aim	This course will cover the main principles of computer programming with a focus on data science applications by following the entire pathway from raw data to databases, data wrangling and visualisation, machine learning frameworks up to software development.
Planned learning outcomes	At the end of the course and having completed the essential reading and activities students should be able to: - convert raw data to relational databases such as SQL - import data to Python and R, apply data manipulation and visualisation - program in Python and R - develop software using version control via Git
Knowledge	
	1. Understand the main principles of programming in the data science context and develop the ability to handle and visualise data. 2. Programming in the Python programming language
Skills	
	1. Be able to computational thinking in various applications domains and learn to communicate data analysis results to stakeholders 2. Account for and discuss the application of i) technologies to convert data to an appropriate format for data analysis ii) algorithms to analyse data through supervised and unsupervised machine learning as well as iii) technologies and performance metrics for evaluation of data analysis results.
Competencies	
	1. Understand the benefits and challenges of data 2. To be able to integrate the steps in a data science process to real life data.
Literature and other sources of information:	
• Compulsory reading	1. Python Data Science Handbook: Essential Tools for Working with Data Paperback. 2023. English edition by Jake Vanderplas 2. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition, Dr. Basant Agarwal, Benjamin Baka, October 31, 2018, ISBN 978-1788995573 3. Guttag, John V., Introduction to Computation and Programming Using Python: With Application to Understanding Data, MIT Press, 2016.

	4. VanderPlas, Jake, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media, 2016. 5. Pieter Spronck. The Coder's Apprentice: Learning Programming with Python 3, (2017). http://www.spronck.net/pythonbook/
• Recommended	1. Grus, Joel, Data Science from Scratch: First Principles with Python, O'Reilly Media, 2015. 2. Hill, Christian, Learning Scientific Programming with Python, Cambridge University Press, 2016. 3. Python website: https://www.python.org/ 4. Free textbook: A Byte of Python https://python.swaroopch.com/

Study course content and schedule of contact hours

Week	Topic	Academic hours	
		full-time	Part-Time intramural
1	Raw data, relational databases models, structured query languages (SQL), data extraction, processing of various human-readable data formats (e.g. JSON, XML, CSV), importing to Python and R, data types and data structures.	6	4
2	Relevant programming concepts, such as IDEs, control flow structures, variables, functions, loops, errors and exception handling, and data input-output operations.	6	4
3	data science problem, going through manipulation and visualisation of data, and, finally, creating actionable insights.	6	4
4	Data cleaning and transformation, representation of data using tabular data structures and their manipulation. Programming and handling data types in R and Python such as scalars, factors, vectors, matrices, arrays, lists and data frames. Introduction to NumPy and Pandas in Python, and the data wrangling utilities in base R	6	4

	and the tidyverse collection of R packages.		
5	Methods for explanatory data analysis, using various statistical plots such as histograms and boxplots, data visualisation plots for time series data, multivariate data, dimensionality reduction methods for visualisation of high-dimensional data, graph data visualisation methods.	6	4
6	Hands on experience with Python (matplotlib and seaborn) and R (base R graphics, ggplot2).	6	4
7	Introduction to Machine Learning via standard frameworks in Python (SciPy, Scikit Learn) and R (glm methods, mlr, caret).	6	4
8	Use of version control via git to share work and collaborate with others in the Data Science industry. Software testing methods and test-driven development (using unit testing). Developing an R package.	6	4
	Total	48 ac.h	32 ac.h

Description of students' self-studies organisation and assignments

Self-study work	**Ac.hours for full-time/ Part-Time intramural/ Part-Time extramural**	**Planned learning outcomes**
Describe the whole data science process	56/64/80	Knowledge, Skills and Competencies: The student can only describe 0-3 procedures in the whole process correctly
Accurately use procedural statements	56/64/80	Knowledge, Skills and Competencies: Less than 50% of procedural statements are used correctly
Total:	112/128/160	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**

1. Home works (Self-study work)	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	Requirements
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 –very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient understanding of some main concepts is detected as well as considerable difficulties in the practical application of the acquired knowledge are stated;
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.

ISMA study course Databases and SQL

Study program	Computer Systems
ECTS	3
Preliminary knowledge, Related study courses	Relational DBMS Foundations
Aim	To provide students with a solid understanding of database management principles and practical skills in using Structured Query Language (SQL) to design, implement, and manage relational databases.
Planned learning outcomes	
Knowledge	1. Understanding of the fundamental principles of relational database systems, including data normalization, indexing, and transaction management. 2. Understanding of the best practices for data management, including data backup and recovery and data security.
Skills	1. The ability to design and develop efficient database schemas, define relationships between tables, and create data models that meet specific business requirements. 2. The ability to write complex SQL queries to retrieve, filter, and manipulate data stored in a relational database system.
Competencies	1. Show the ability to apply their knowledge of databases and SQL to solve real-world problems related to data management, analysis, and application development. 2. Show the ability to communicate technical information effectively to both technical and non-technical stakeholders, including managers, clients, and colleagues.
Literature and other sources of information:	
● Compulsory reading	1. Database Design for Mere Mortals: 25th Anniversary Edition (4th Ed), Michael J. Hernandez, Addison-Wesley Professional, 2020. 2. Database systems: the complete book, Pearson.; Garcia-Molina, Hector; Ullman, Jeffrey D.; Widom, Jennifer, Pearson Education Limited, 2013/2014.
● Recommended	1. Cracking the SQL Interview for Data Scientists: Nervous about your SQL Interview? Anxiety ends here. Learn, refresh and master SQL Skills in a Week, Leon Wei, 2021.

Study course content and schedule of contact hours

Week	Topic	Academic hours

		full-time	part-time intramural
1	Introduction and orientation. Introduction to databases and SQL.	2	1
2	Relational database design principles.	2	2
3	SQL data types and operators. Querying data with SELECT.	2	2
4	Filtering and sorting data. Joining multiple tables.	2	2
5	Aggregating and grouping data. Subqueries and derived tables.	2	2
5	Modifying data with INSERT, UPDATE, and DELETE statements.	2	1
7	Creating and managing databases, and tables.	2	1
8	Indexing and performance optimization. Transactions and concurrency control.	2	1
9	Stored procedures and functions.	2	1
10	Triggers and event-driven programming.	2	1
11	Securing databases and data privacy.	2	1
12	Backup and recovery strategies. Wrapup.	2	1
	Total:	24 ac.h	16 ac.h

Description of students' self-studies organisation and assignments

Self-study work	**Ac.hours for full-time/ part-time intramural/ distance studies extramural**	**Planned learning outcomes**
1. Compulsory reading, sources, and methodological materials learning	12/16/20	Knowledge, Skills and Competencies: Students studied the core concepts behind relational databases, design and administration, as well as SQL syntax.
2. Familiarization with Terminal and VSCode IDE with SQL plugin for DB administration.	12/16/20	Knowledge, Skills and Competencies: Students understand and are able to setup tools necessary for development and administration of the relational SQL DB system.
3. Familiarization with design and development of the relational databases.	12/16/20	Knowledge, Skills and Competencies: Students understand and can apply DB systems design principles for logical and physical model

		implementation as well as data retrieval.
4. Practical Exercises	12/16/20	Knowledge, Skills and Competencies: Students will be able to design, implement and manage DB systems according to a specification.
Total:	48/64/80	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**
1. Homeworks	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	**Requirements**
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems; 9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 –very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient understanding of some main concepts is detected as well as

	considerable difficulties in the practical application of the acquired knowledge are stated;
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.

ISMA study course Data Analysis

Study program	Computer Systems
ECTS	3
Preliminary knowledge, Related study courses	Introduction to programming using Python
Aim	To provide students with the knowledge and skills needed to perform exploratory data analysis, data cleansing, and modeling using a variety of machine learning techniques. By the end of the course, students will have gained practical experience in Python programming, using libraries such as Pandas and Numpy, and will have a solid understanding of regression, classification, clustering, and neural network algorithms.
Planned learning outcomes	
Knowledge	1. Understanding of data science concepts, including exploratory data analysis, data cleansing and imputation, and model selection techniques. 2. Familiarity with a variety of machine learning algorithms, including regression, classification, clustering, and neural networks.
Skills	1. Proficiency in using Python programming language and related libraries, such as Pandas and Numpy, for data analysis and modeling. 2. Ability to implement data preparation and machine learning techniques, such as regression and clustering, to solve real-world problems.
Competencies	1. Ability to analyze and interpret complex data sets using a variety of statistical and machine learning techniques. 2. Proficiency in designing and implementing machine learning models to solve business problems and extract insights from data.
Literature and other sources of information:	
• Compulsory reading	1. "Data Science from Scratch: First Principles with Python" by Joel Grus (2019) 2. Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter by Wes McKinney Sep 20, 2022 3. Everything Data Analytics A Beginner's Guide to Data Literacy: Understanding the Processes That Turn Data Into Elizabeth Clarke, 2022 4. The Hundred-Page Machine Learning Book by Andriy Burkov (2019) 5. "Hands-On Machine Learning with Scikit-Learn and TensorFlow" by Aurélien Géron (2017)

	6. "The Elements of Statistical Learning: Data Mining, Inference, and Prediction" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman (2017)
• Recommended	1. "The Practice of Cloud System Administration: Designing and Operating Large Distributed Systems" by Thomas A. Limoncelli, Strata R. Chalup, and Christina J. Hogan, 2020. 2. "Data Mining: Concepts and Techniques" by Jiawei Han and Micheline Kamber (2018) 3. "Practical Statistics for Data Scientists: 50 Essential Concepts" by Peter Bruce and Andrew Bruce (2018) 4. "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili (2017)

Study course content and schedule of contact hours

Week	Topic	Academic hours	
		full-time	**part-time intramural**
1	Course Orientation and Introduction to Data Analysis	2	1
2	Python, Libraries, and Jupyter Notebooks/Lab.	2	1
3	Pandas DataFrames, Numpy. Exploratory Data Analysis.	2	1
4	Data Cleansing/Imputation, Data preparation & model selection techniques.	2	1
5	Linear Regression, Logistic Regression, Linear Regression Regularization and KNN.	2	2
5	Decision Trees.	2	2
7	Support Vector Machines (SVM).	2	1
8	Introduction to Artificial Neural Networks.	2	2
9	Fully Connected Feed-forward Artificial Neural Networks.	2	1
10	Clustering Analysis.	2	1
11	Kohonen Neural Networks.	2	1
12	Bayesian Learning.	2	2
	Total:	24 ac.h	16 ac.h

Description of students' self-studies organisation and assignments

Self-study work	**Ac.hours for full-time/ part-time intramural/ distance studies extramural**	**Planned learning outcomes**
1. Compulsory reading, sources, and methodological materials learning.	12/16/20	Knowledge, Skills and Competencies: Students will get a solid understanding of the core concepts and techniques in data analysis, machine learning, and

		statistical modeling. Students will also learn how to use relevant tools and software, such as Python, Jupyter Notebooks/Lab, and related libraries and packages, to implement and apply these concepts.
2. Familiarization with exploratory data analysis and related libraries.	12/16/20	Knowledge, Skills and Competencies: Students will gain familiarity with exploratory data analysis and related libraries, such as Pandas and Numpy, to effectively process and analyze large and complex datasets. Students will learn how to apply statistical techniques and visualizations to identify patterns, trends, and relationships in data.
3. Familiarization with classification, regression, and clustering analysis.	12/16/20	Knowledge, Skills, and Competencies: Students will become familiar with a range of classification, regression, and clustering analysis techniques, including linear regression, logistic regression, decision trees, support vector machines (SVM), and neural networks. Students will learn how to use these techniques to build predictive models and gain insights from data.
4. Practical Exercises.	12/16/20	Knowledge, Skills and Competencies: Students will be able to apply the concepts and techniques they have learned to real-world problems. Students will work on data preparation, modeling, and analysis tasks, gaining hands-on experience with tools and methods used in data analysis and machine learning
Total:	48/64/80	

Study work	**Knowledge**	**Skills**	**Competences**	**% of final evaluation**
1. Homeworks	+	+	+	50
2. Exam	+	+	+	50

Evaluation of mastering the study course

Level	**Requirements**
Very high (10 –with distinction 9 – excellent)	10 (with distinction) - knowledge, skills and competences exceed the requirements of the study course and demonstrate the ability to perform independent research as well as the deep understanding of problems;

	9 (excellent) - knowledge, skills and competences fully meet the requirements of the study course, student is able to apply the acquired knowledge independently;
High (8 –very good 7 - good)	8 (very good) – the requirements of the study course are fully met, however, there is insufficient understanding of individual issues to use the knowledge independently for the solution of more complex problems; 7 (good) – the requirements of the study course are met in general, however, sometimes the inability to use the acquired knowledge independently is detected;
Average (6 – almost good 5 – satisfactory 4 –almost satisfactory)	6 (almost good) –. the requirements of the study course are met in general, however insufficient understanding of some problems and inability to apply the acquired knowledge is detected; 5 (satisfactory) – the requirements of the study course are met for the most part, however insufficient understanding of many problems and inability to apply the acquired knowledge is detected; 4 (almost satisfactory) – the requirements of the study course are met, for the most part, however insufficient understanding of some main concepts is detected as well as considerable difficulties in the practical application of the acquired knowledge are stated;
Low (3 – 1 – negative evaluation)	3 (bad) – knowledge is superficial and incomplete; the student is unable to use it in specific situations; 2 (very bad) – superficial and incomplete knowledge of only some problems, the most part of the study course is not mastered; 1 (very very bad) – an absence of understanding of the main problems of the subject matter, almost no knowledge of the content of the study course.