

**WOJSKOWA AKADEMIA TECHNICZNA**  
im. Jarosława Dąbrowskiego  
(*Military University of Technology*)

**PROGRAMME OF STUDY**

Level: **Second cycle studies**

Major: **Data Science**

*Resolution of the Senate of Wojskowa Akademia Techniczna  
im. Jarosława Dąbrowskiego  
No. 23/WAT/2022 of February 24, 2022*

*authorising the adoption of a programme of study  
for a degree in Data Science*

*Effective from the academic year 2022-2023*

## **PROGRAMME OF STUDY**

### **Major: DATA SCIENCE**

Level: **Second cycle studies**

Profile: **General academic profile**

Mode: **Full-time**

Degree awarded to graduates: **magister inżynier (Master Engineer)**

Polish Qualifications Framework Level: **7**

Classification of the major:

Branch of science: **Information and Communication Technology Sciences**

Scientific field: **Data Science (100% ECTS)**

Language of instruction: **English**

No. of semesters: **3**

Total no. of hours: **734**

No. of ECTS credits required to complete the studies: **90**

Total no. of ECTS credits that students must earn in the course of the studies:

- courses with direct participation of academic teachers or other instructors:
  - o **49**
- humanities or social sciences courses:
  - o **5**

Length, no. of ECTS credits, rules and form of internship: **No internship required by the programme of study.**

## 1. THE LEARNING OUTCOMES

**The description of learning outcomes includes:**

- universal first-cycle characteristics set out in the Appendix to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Appendix to the Regulation of Minister of Science and Higher Education of 14 November 2018 on the second cycle characteristics of learning outcomes for level 6-8 qualifications of the Polish Qualifications Framework, including requirements for obtaining engineering qualifications<sup>1</sup>

**and it comprises three categories:**

- the **knowledge (W)** category which specifies:
  - size and depth (**G**) - completeness of the cognitive perspective and relationships,
  - context (**K**) - conditions, effects.
- the **skills (U)** category which specifies:
  - in terms of application of knowledge (**W**) - problems to be solved and tasks to be performed,
  - in terms of communication (**K**) - receiving and formulating statements, spreading knowledge in the scientific community and speaking a foreign language,
  - in terms of work organisation (**O**) - planning and teamwork,
  - in terms of learning (**U**) - planning own personal development and development of others.
- the **social competences (K)** category which specifies:
  - in terms of evaluations (**K**) - critical approach,
  - in terms of responsibility (**O**) - fulfilling civic duties and acting in the public interest,
  - in terms of professional role (**R**) - independence and formation of professional ethos.

Symbols:

- in the **Outcome Symbol and Number** column:
  - **K** - major-specific learning outcomes;
  - **W**, **U**, **K** (after underscore) - category: **W** for knowledge, **U** for skills, **K** for social competences;
  - 01, 02, 03, ... - no. of learning outcome.
- in the **Description Component Code** column: Inż<sup>2</sup>\_P7S4\_WG – *description component code for second-cycle characteristics for level 7 qualifications of the Polish Qualifications Framework.*

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<sup>1</sup> Applicable to majors that finish with the award of the following degrees: inż., mgr inż.

<sup>2</sup> For engineering qualifications.

According to the regulation of the minister competent for higher education and science, some of the learning outcomes included in the curriculum may be achieved through classes conducted with the use of **distance learning methods and techniques as well as infrastructure and software ensuring synchronous and asynchronous interaction** between students and lecturers conducting the classes.

Outcome Symbol and Number	Description of Learning Outcomes	Description Component Code
<b>KNOWLEDGE</b>		<b>Graduate:</b>
K_W01	Has a deep knowledge and understanding of the nature, role and significance of social sciences and humanities and of their relationship to other sciences.	P7S_WG
K_W02	Has a deep knowledge and understanding of mathematics required to: analyse, model, construct and maintain computer information systems.	P7S_WK
K_W03	Has a deep knowledge of the latest development trends, innovative solutions, modern methods and tools in the design, development, securing, implementation, maintenance and improvement of computer information systems.	P7S_WK P7S_WG Inż_P7S_WG
K_W04	Has a deep knowledge and understanding of the theory of algorithms and data structures, data management and tools, models, methods and methodologies for designing computer information systems (of different classes and types).	P7S_WG Inż_P7S_WG
K_W05	Has a deep knowledge and understanding of methods and tools used to model objects and systems, formulate and solve decision-making problems and problems in the field of computational intelligence, data science, data mining and machine learning.	P7S_WG
K_W06	Has a deep knowledge and understanding of the principles of computer networks, network services, design and management of computer networks including administration of network operating systems.	P7S_WG
K_W07	Has a knowledge and understanding of methods and techniques for securing computer information systems.	P7S_WG
K_W08	Has a knowledge of the economic and environmental aspects of production and use of materials to the extent necessary to understand the social, economic, legal and other non-technical effects of engineering. Is acquainted with the cost components of production, the environmental hazards associated with production and use of materials and ways to protect the environment.	P7S_WG
K_W09	Has a knowledge and understanding of basic concepts, rules and regulations of law pertinent to industrial property and copyright protection. Knows the rules governing the use of patent data.	P7S_WK
K_W10	Knows general rules guiding the formation and development of individual enterprises, in particular in the sectors of economy that rely on the findings of engineering.	P7S_WK Inż_P7S_WG
K_W11	Has a knowledge and understanding of the principles of construction and execution of encryption algorithms.	P7S_WK

Outcome Symbol and Number	Description of Learning Outcomes	Description Component Code
<b>SKILLS</b> <span style="float: right;"><b>Graduate:</b></span>		
K_U01	Is able to identify and interpret the fundamental social, humanistic and legal phenomena and processes to the extent relevant to the chosen field of study.	P7S_UK Inż_P7S_UW
K_U02	Is able to use the language of mathematics, to formulate and solve problems in the field of data science using mathematical methods.	P7S_UW Inż_P7S_UW
K_U03	Is able to work in a team, manage a project team, make a critical analysis of the existing technical solutions, an initial economic assessment and manage the processes of implementation, maintenance and improvement of information systems, as well as communicate with the end-users.	P7S_UW P7S_UO P7S_UK Inż_P7S_UW
K_U04	Is able to manage processes of analysis and documentation of design and research tasks with the application of software engineering and selected methods and tools of software development.	P7S_UW Inż_P7S_UW
K_U05	Is able to use a deep knowledge of the principles of operation of network services, design and management of computer networks, including administration of network operating systems as an environment for acquisition, management, analysis and presentation of information.	P7S_UW
K_U06	Is able to apply innovative technologies, implement selected system virtualization techniques, solve selected tasks in the field of telematics and robotics, mobile networks, wireless sensor networks and the Internet of Things.	P7S_UW Inż_P7S_UW
K_U07	Is able to apply methods and techniques for securing data-driven systems.	P7S_UW Inż_P7S_UW
K_U08	Is able to apply knowledge of programming languages and advanced algorithmic techniques to the implementation of complex data model and machine learning systems.	P7S_UW Inż_P7S_UW
K_U09	Is able to use methods of classification and signal analysis to create recognition systems (including biometric systems), design Internet applications and multimedia services using multimedia streaming technologies.	P7S_UW Inż_P7S_UW
K_U10	Demonstrates a knowledge of foreign language consistent with B2+ level according to the Common European Framework of Reference for Languages, which allows for spoken and written communication on general topics and advanced communication using specialist terminology.	P7S_UK
K_U11	Is able and ready for project-based learning and development of competences, knows how to inspire others to learn.	P7S_UU
K_U12	Is able to use selected cryptographic algorithms.	P7S_UW
<b>SOCIAL COMPETENCES</b> <span style="float: right;"><b>Graduate:</b></span>		
K_K01	Recognises the need for continuous learning and development of competences, knows how to inspire others to learn.	P7S_KK

Outcome Symbol and Number	Description of Learning Outcomes	Description Component Code
K_K02	Is ready to fulfil social obligations, co-organise activities in the public interest, initiate action in the public interest.	P7S_KO
K_K03	Recognises the non-technical aspects and effects of engineering and research activities. Is able to assess their impact on the environment.	P7S_KO
K_K04	Interacts with a group, inspires and organises public interest initiatives.	P7S_KO
K_K05	Is capable of leading a team.	P7S_KO
K_K06	Is ready to fulfil professional roles responsibly, in particular to comply with the rules of professional ethics and to require others to do so, as well as to care for the achievements and traditions of the profession.	P7S_KR

## 2. SUBJECTS

Subject groups / subjects<sup>3</sup>, their brief description (framework programmes), assigned ECTS credits and learning outcomes (reference to major-specific outcomes)

No.	Subject group, subject name: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
<b>General Education - General Subjects</b>				
1.	<b><i>Occupational Health and Safety</i></b> <u>Contents of the framework programme:</u> Current OHS legislation. Occupational (educational) health and safety - safety procedures required in a specific job (activity) according to scientific and technical rationale. Protection from hazards to students' health and safety. Use of personal protective equipment in class (tutorials). Accident insurance. Procedures to be followed in case of accidents and in hazardous situations. Premedical first aid training.			K_W10
2.	<b><i>Selected Topics in Psychology</i></b> <u>Contents of the framework programme:</u> The course covers selected topics in general and social psychology. It allows students to broaden and extend their psychological knowledge about oneself and others, useful at work and in everyday life, and to develop practical skills: open-mindedness, willingness to take on challenges, out-of-the-box thinking and teamwork skills.	2,5	NS	K_W01, K_U01, K_K02, K_K03, K_K04, K_K06
<b>Core Education - Core Subjects</b>				
1.	<b><i>Communication and Fundamentals of Negotiation</i></b> <u>Contents of the framework programme:</u> Conflict sources and resolution. The process, types and functions of communication. The essence and types of negotiation. Negotiation strategies, styles and tactics. Personality traits of negotiators. Common negotiation mistakes. Communication in negotiation. Negotiation in practice.	2,5	NZJ	K_W09, K_W11, K_U10, K_U14, K_K01, K_K05, K_K06
2.	<b><i>Economics</i></b> <u>Contents of the framework programme:</u> Introduction to the study of economics. The market economy. Basics of consumer decisions, consumer demand. Production and costs. Models of market structures. National income account. Determinants of national income. Macroeconomic equilibrium. Global demand and fiscal policy. Banking system and money supply. Monetary and fiscal policy. Inflation - causes and effects.	2	EF	K_W01, K_U01, K_K03, K_K05,

<sup>3</sup> Subject information sheets are prepared and made available 30 days before the start of the semester in which the subject is to be taught.

No.	Subject group, subject name: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
<b>Major Education - Major Subjects</b>				
1.	<p><b><i>Statistics</i></b>  <u>Contents of the framework programme:</u>            Subject of statistics: data classification and graphic presentation. Frequency distributions. Measures of central tendency and variation. Dynamical analysis of phenomena. Analysis of correlation. Analysis of regression. Probability space as a model for phenomena with statistical regularity. Random variable. Parameters of random variable. Correlation and covariance. Fundamental distributions of random variables. Normal Distribution. Probability distributions as models of real-world phenomena. Statistical inference. Basic statistics. Distributions of selected statistics. Interval estimation. Verification of parametric hypotheses. Verification of nonparametric hypotheses.</p>	<b>3</b>	M	K_W02, K_U02, K_K01
2.	<p><b><i>Data Centers and HPC Systems</i></b>  <u>Contents of the framework programme:</u>            Introduction to the architecture and organization of contemporary servers. Issues related to server performance optimization as well as bandwidth and use of buses (PCI-E, UPI, Infinity Fabric). Organization of Data Centers and High Performance Computing (HPC) systems. Network connection standards and understanding HPC cluster network topologies. Example data centers - location and buildings; floor and ceiling; equipment racks; scalable network connections; light, power and cooling infrastructure; fire protection and safety; monitoring and security.</p>	<b>3</b>	ITT	K_W03, K_W07, K_U03, K_U07, K_K05
3.	<p><b><i>Data Modelling Techniques</i></b>  <u>Contents of the framework programme:</u>            Introduction to data modelling. Data modelling concepts. Data modelling types. Data model standards. Conceptual data model. Entity Relationship Diagram. Logical data model. Normalization theory. Dimensional data modelling. NoSQL data modelling. Data modelling tools.</p>	<b>3</b>	ITT	K_W05, K_U04, K_U11, K_K06
4.	<p><b><i>Artificial Intelligence</i></b>  <u>Contents of the framework programme:</u>            Definition of artificial intelligence and areas of its application, Formal systems - alphabet, properly defined formulas, axioms, Inference rules, the propositional calculus, the calculus of predicates, pre-processing formulas, theorems, the automatic theorem proving algorithm, trees of deduction, clause set processing, Fundamentals of genetic algorithms. Introduction to machine learning.</p>	<b>3</b>	ITT	K_W05, K_U02, K_U04, K_U11, K_K06
5.	<p><b><i>Data Mining</i></b>  <u>Contents of the framework programme:</u>            Basic concepts of data mining. Classification of data mining problems. Prediction problems, Classification. Grouping and association discovery. Fundamentals of machine learning used in data mining: decision trees, naive Bayesian classifier, j-nearest neighbours, k-means method, agglomeration method, binary association rule discovery methods. Data mining tools. Model evaluation methods.</p>	<b>3</b>	ITT	K_W05, K_U03, K_U04, K_U11, K_K06



No.	Subject group, subject name: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
6.	<b><i>Mathematical Foundation of Data Science</i></b> <u>Contents of the framework programme:</u> The course is to providing knowledge of methods and algorithms with computational skills involving selected topics of numerical linear algebra and optimisation fundamental in data processing. Basic ideas and problems as floating-point arithmetic, systems of linear algebraic equations, linear least-squares problems, minimisation of quadratic functionals and scalar non-linear equations will be presented at lectures together with method and algorithms for solving them applying matrix factorisations and decompositions, secant method, conjugate gradient method. Laboratory exercises with using advanced computational tools will be dedicated to developing effective computational skills of participants.	4	ITT	K_W02, K_U02, K_K01
7.	<b><i>Data Analysis and Visualization</i></b> <u>Contents of the framework programme:</u> Acquisition, ordering and preliminary evaluation of data. Review analysis of data: outlier observations, descriptive statistics, one and two dimensional tables, factorization of variables. Analysis of variance. Analysis of covariance. Factor analysis. Multivariate Reduction. Visualization of descriptive statistics and distributions (box plot, histogram). Visualization of relationships in time series (bar chart, stacked bar chart, dot chart, high-density plots, line plots, step chart, lift chart). Visualization of proportions (charts: pie chart, tree map chart, stacked bar chart, stacked area chart, tree-map chart). Visualization of relationships using charts: dot plots, bubble plots, histograms, graphs. Spatial data visualization.	4	ITT	K_W05, K_U04, K_U11, K_K06
8.	<b><i>Neural Networks</i></b> <u>Contents of the framework programme:</u> Introduction to linear classification of data - idea of perceptron; neural net as tool of nonlinear classification; minimization procedure for estimation error; constraints for results of estimation error; supervised learning of NN; ADALINE; Hebb rules; Kohonen net- unsupervised learning; evolution of Kohonen net - SNN; semi-supervised learning; reinforcement learning; introduction to convolution network	4	ITT	K_W05, K_U02, K_U04, K_U11, K_K06
9.	<b><i>Functional Programming</i></b> <u>Contents of the framework programme:</u> Basic of functional programming with Python; structural object in Python; mutable and nonmutable objects; functions and modules; lambda expression; OOP programming in Python; types for methods in class; namespace in Python; libraries and tools for Python; decorators for function; decorators for class; descriptor.	4	ITT	K_W05, K_U04, K_U11, K_K06
10.	<b><i>Virtualization and Cloud Computing</i></b> <u>Contents of the framework programme:</u> Discussion the potential of available computer hardware resources, divided into three groups: compute and memory, storage and availability, network and security. Introduction to the issues of emulation and virtualization. The essence of virtualization in the case of modern IT systems. Overview of virtualization software - administration and exploration. The use of virtualization to create the basic model of cloud computing (i.e. IaaS). Survey of cloud computing models. Trends of virtualization, cloud computing and IT market development.	3	ITT	K_W04, K_W08, K_U04, K_U06, K_K05

No.	Subject group, subject name: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
11.	<p><b><i>Stochastic Processes in Data Science</i></b>  <u>Contents of the framework programme:</u>            The course is an graduate course on stochastic processes and their applications in computer data science. The course focuses on several classes of stochastic processes which are often used in various applications: Markov chains, hidden Markov chains, random walks, branching processes, and Brownian motion as well as stationary and non-stationary time series. Renewal and regenerative processes are also discussed. Lectures and hands-on activities allow to explore the mathematical tools and techniques necessary to understand and effectively use stochastic processes in a variety of applications in computer data science. The course emphasizes the construction of stochastic models for various applications in computer science.</p>	4	M	K_W02, K_U02, K_K01
<b>Elective Subjects</b>				
1.	<p><b><i>Data Warehouse Design and Development</i></b>  <u>Contents of the framework programme:</u>            Data warehouse architecture, dimensional modelling: facts and dimensions, SCD, data integration, data cleansing, ETL, multidimensional structures. Data visualization tools, management dashboards, scorecards, Business Performance Management, self-service BI, analytical extensions of SQL, basics of MDX and DAX. Data lineage, metadata management, data governance.</p> <p><b><i>Data Center Services on Linux Systems</i></b>  <u>Contents of the framework programme:</u>            The subject considers security mechanisms in data services running on Linux systems. The topics of the subject include: data storage management technologies: software matrices, logical volumes, distributed file systems, encrypted volumes; securing files, directories and volumes; backup copies; environments for mass analysis and storage of large data sets as well as system services integration.</p>	3	ITT	<p style="text-align: center;">K_W05, K_U03, K_U04, K_U11, K_K06</p> <p style="text-align: center;">K_W03, K_W06, K_W07, K_U05, K_U07, K_K06</p>
2.	<p><b><i>Database Design and Development - SQL and No-SQL</i></b>  <u>Contents of the framework programme:</u>            Logical database design (SQL and noSQL). Normalization. Physical design. Data types. SQL DDL for building the physical database. SQL DML for data manipulation. Sample data and CRUD operations. Creating and managing views. Creating additional database objects. Maintaining database security. Database transactions. Query performance optimization.</p> <p><b><i>Image Processing</i></b>  <u>Contents of the framework programme:</u>            RGB and image standards. Histograms. Tone curves. Filtration. Segmentation. Image pre-processing. Frameworks and tools for image transformation. Wavelet transformation. Image as 2D signal. Data mining in images. Python tools for image processing.</p>	3	ITT	<p style="text-align: center;">K_W05, K_U08, K_U04, K_U11, K_K06</p> <p style="text-align: center;">K_W05, K_U04, K_U11, K_K06</p>

No.	Subject group, subject name: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
3.	<p><b><i>Graph Mining</i></b>  <u>Contents of the framework programme:</u>            Network modelling, measures of the characteristics of networks. Identification of important groups (nodes, edges) in the network. Link analysis. Models and methods of graphs and networks similarity, subgraph similarity. Graph clustering. Graph filtering. Modelling and simulation of the propagation of phenomena in networks. Applications of graph mining in pattern recognition, semantic networks, diagnosing and improving the organisation's structure, information warfare.</p>	3	ITT	K_W05, K_U02, K_U04, K_U11, K_K06
	<p><b><i>Data Analytics for Computer Networks</i></b>  <u>Contents of the framework programme:</u>            The subject considers the analysis of data transmitted over a computer network. The detailed topics of the subject include: protocols and tools for monitoring network traffic, mechanisms for ensuring the quality of service in computer networks, virtual private networks and methods of integrating IPv4 networks with IPv6 networks.</p>			K_W06, K_U02, K_U05, K_U11, K_K06
4.	<p><b><i>Database Management Systems</i></b>  <u>Contents of the framework programme:</u>            Introduction to database management systems. Structured query language - SQL DDL and SQL DML. foundations of database management. Operational (OLTP) and decision-support (OLAP) purposes of database. Storage structures, indexing and its impact on query plans. Database performance tuning. Database Recovery Techniques.</p>	3	ITT	K_W05, K_U04, K_U11, K_K06
	<p><b><i>Detection and Analysis of Computer Network Security Threats</i></b>  <u>Contents of the framework programme:</u>            Detection and Analysis of Computer Network Security Threats            Contents of the framework programme: The subject considers the detection and analysis of threats in computer networks. The topics of the subject include: detection of threats in layers II and III of the reference model; Intrusion Prevention Systems and signature analysis, stateful and stateless firewalls as well as next generation firewalls.</p>			K_W07, K_W06, K_W03, K_U03, K_U05, K_U07, K_U11, K_K06
5.	<p><b><i>Machine Learning</i></b>  <u>Contents of the framework programme:</u>            A survey of Machine Learning applications. Overview of theoretical foundations of machine learning. Model and its parameters, cost function, and gradient descent based on the example of linear regression. Logistic regression with multiple parameters. Regularization. Computation graph, gradient descent optimizers. Artificial Neural Networks: artificial neuron unit, activation functions, multilayer perceptron, backpropagation. Batches, learning epochs. Training, validation, and test data sets. Kernel density estimators. Classifier boosting methods: bagging algorithms, boosting algorithms. Random forests. Principal component algorithms. Cross-validation, sampling, SVM.</p>	3	ITT	K_W05, K_U02, K_U04, K_U11, K_K06

No.	Subject group, subject name: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	<p><b><i>Windows Services Security in Data Center</i></b>  <u>Contents of the framework programme:</u>            The subject considers security mechanisms in Data Center services running on Microsoft Windows Server. Detailed topics include: review of system data protection mechanisms; file system-based security: system permissions, Encrypting File System, Bitlocker, Volume Shadow Copy Service, offline files, Distributed File System and backups; cryptographic data protection, system audit policy and event viewing mechanism.</p>			K_W03, K_W06, K_W07, K_U05, K_U07, K_K06
6.	<p><b><i>Deep Learning</i></b>  <u>Contents of the framework programme:</u>            Overview of deep learning models: deep belief networks, convolutional neural networks, recurrent neural networks, GRU, LSTM, Transformers. Hyperparameter tuning, dropout, batch normalization, residual layers, transfer learning. Selected Deep Learning frameworks (Pytorch, Keras, Tensorflow)</p> <p><b><i>Computer Vision</i></b>  <u>Contents of the framework programme:</u>            Introduction to issues of high-level digital images analysis and understanding. Pre-processing, feature extraction, segmentation, classification, symbolic representation, interpretation and description of digital images in computer vision systems. Regular objects recognition methods. Irregular patterns learning and matching techniques. Applying theories and models to the construction of computer vision systems. Examples of computer vision applications.</p>	<b>3</b>	ITT	<p>K_W05, K_U02, K_U04, K_U11, K_K06</p> <p>K_W05, K_U08, K_U09, K_K01</p>
7.	<p><b><i>Natural Language Processing</i></b>  <u>Contents of the framework programme:</u>            General overview of methods and applications of natural language processing, probabilistic language models: Bag of Words, TF-IDF Matrix, Zipf law, N-gram models. Document Similarity, Document classification. Topic modelling, Latent Semantic Analysis, SVD. Hidden Markov Models, syntactic analysis: Part of Speech Tagging, Tagsets, Shallow parsing/deep parsing. Semantic analysis: ontologies, knowledge graphs, information extraction. Overview of neural network models for language processing tasks: sequence models, deep learning, attention mechanism, transformers.</p> <p><b><i>Application of Cryptography in IT Systems</i></b>  <u>Contents of the framework programme:</u>            Fundamentals of cryptology: cryptosystem definition, symmetric and asymmetric encryption, hash function. Applications of cryptology: data encryption and integrity verification, PKI, X509 standard, PGP, electronic signature, VPN. Security of selected IT services.</p>	<b>3</b>	ITT	<p>K_W05, K_U08, K_U04, K_U11, K_K06</p> <p>K_W07, K_W11, K_U07, K_U12, K_K05</p>
8.	<p><b><i>Machine Learning - Team Project</i></b>  <u>Contents of the framework programme:</u>            Application of machine learning models (deep neural networks) in real-life scenarios like object detection, document classification. Teams use data science competition platform (i.e. Kaggle) to submit their models, trying to achieve the best model performance.</p>	<b>2</b>	ITT	K_W05, K_U03, K_U04, K_U11, K_K06

No.	Subject group, subject name: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	<p><b><i>Data Mining - Team Project</i></b>  <u>Contents of the framework programme:</u>  Teams develop their analytical skill by conducting exploratory data analysis. Their task is to find outliers, patterns, clusters, correlations in a provided data set, and then communicate effectively the findings with impactful visualizations (storytelling with data).</p>			K_W05, K_U03, K_U04, K_U11, K_K06
<b>Thesis</b>				
1.	<p><b><i>Graduation Seminar</i></b>  <u>Contents of the framework programme:</u>  Faculty and university guidelines for Magister thesis and final examination. Students present the idea for their final project. Magister thesis writing techniques. Avoiding plagiarism in Magister thesis. Overview of visual communication techniques. Preparation for final examination. Magister thesis progress reporting.</p> <p><b><i>Graduation Laboratory</i></b>  <u>Contents of the framework programme:</u>  Faculty and university guidelines for Magister thesis and final examination. Students present the idea for their final project. Magister thesis writing techniques. Avoiding plagiarism in Magister thesis. Overview of visual communication techniques. Preparation for final examination. Magister thesis progress reporting.</p>	<b>2</b>	ITT	K_K03, K_K04, K_U10, K_W02, K_W03, K_W04, K_W05, K_W06, K_W07, K_W11  K_K03, K_K04, K_U10, K_W02, K_W03, K_W04, K_W05, K_W06, K_W07, K_W11
2.	<p><b><i>Thesis</i></b>  <u>Contents of the framework programme:</u>  Choosing a thesis topic. Conducting a literature review on the chosen topic and proposing a method(s) of solving the problem. Conducting appropriate experiments or reviews, review and design or design using available tools and methods. Presenting results in charts, tables, drawings or in the text form. Using the skills acquired throughout the studies, improving individual work and self-directed learning skills and technical problem solving skills. The scope of work to be performed in the course of the thesis writing process is set out in a thesis schedule which should be used to monitor student's progress with the thesis. The schedule is amended according to the needs of the thesis.</p>	<b>20</b>	ITT	K_K06, K_U10, K_W02, K_W03, K_W04, K_W05, K_W06, K_W07, K_W11
<b><i>Total</i></b>		<b>90</b>		

### **3. METHODS OF VERIFICATION AND ASSESSMENT OF LEARNING OUTCOMES**

#### **Methods of verification and assessment of learning outcomes<sup>4</sup> achieved by the student throughout the entire education cycle**

The achievement of learning outcomes achieved by the student throughout the entire education cycle is assessed primarily on the basis of grades in exams and non-examinable subjects as well as grades for projects or studies presented at seminars. It is also checked whether student was struck off the register in particular academic years. The ultimate test of the learning outcomes is the thesis writing process. To be able to take the final exam student must meet the requirements set out in the programme of study and submit his/her thesis which must receive a passing grade from thesis supervisor and reviewer. Moreover, a lot of attention is given to results of surveys of graduates.

Some of the learning outcomes included in the curriculum may be verified with the use of distance learning methods and techniques as well as infrastructure and software ensuring synchronous and asynchronous interaction between students and lecturers.

The choice of the method of verification of learning outcomes depends on the type of classes and number of hours. Prior to laboratory classes students take a test assessing their knowledge of the task at hand, and after the task is completed students write reports in which they analyse the results and formulate conclusions on the basis of theoretical knowledge.

Students' skills are evaluated on a regular basis in class and through written tests covering particular units of the course. Students' theoretical knowledge is assessed through oral and written assessments and exams. Student's ability to independently solve problems and present them in a systematic written form is evidenced by their thesis. The ability to discuss topics related to the studied area and present results of research is checked during subject seminars and graduation seminars.

Detailed information on the methods of verification of learning outcomes achieved by students is provided in subject information sheets. However, it is recommended to use the following levels of achievement of expected outcomes when assessing the student:

- Very good grade is awarded to the student who has achieved the expected learning outcomes at the level of 91-100%.
- Good plus grade is awarded to the student who has achieved the expected learning outcomes at the level of 81-90%.
- Good grade is awarded to the student who has achieved the expected learning outcomes at the level of 71-80%.
- Sufficient plus grade is awarded to the student who has achieved the expected learning outcomes at the level of 61-70%.
- Sufficient grade is awarded to the student who has achieved the expected learning outcomes at the level of 51-60%.
- Insufficient grade is awarded to the student who has achieved the expected learning outcomes at the level equal or lower than 50%.

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<sup>4</sup> Overview only - for details see specific subject information sheets

## 4. PLAN OF STUDIES

SUBJECT GROUPS / SUBJECTS		Scientific field	Total no. of hours / ECTS credits		ECTS / science skills development	ECTS / part of academic	Including:					no. of hours/evaluations/ECTS credits per semester:				organisational unit administering the course	Comments		
			hours	ECTS			lecture	tutorial	laboratory	project	seminar	I		II				III	
												hours	ECTS	hours	ECTS			hours	ECTS
<b>A. General Subjects</b>			<b>24</b>	<b>2,5</b>	<b>1,0</b>	<b>1,5</b>	<b>18</b>	<b>6</b>				<b>24</b>	<b>2,5</b>						
1	Occupational Health and Safety		4				4					4	+				ZBHP		
2	Selected Topics in Psychology	NS	20	2,5	1,0	1,5	14	6				20	+	2,5			WBL/IOZ		
<b>B. Core Subjects</b>			<b>40</b>	<b>4,5</b>	<b>2,0</b>	<b>2,5</b>	<b>28</b>	<b>12</b>				<b>20</b>	<b>2,5</b>	<b>20</b>	<b>2,0</b>				
1	Communication and Fundamentals of Negotiation	NZJ	20	2,5	1,0	1,5	14	6				20	+	2,5			WBL/IOZ		
2	Economics	EF	20	2	1,0	1,0	14	6						20	+	2	WBL/IOZ		
<b>C. Major Subjects</b>			<b>372</b>	<b>38,0</b>	<b>27,0</b>	<b>22,0</b>	<b>136</b>	<b>20</b>	<b>198</b>	<b>18</b>		<b>208</b>	<b>19,0</b>	<b>164</b>	<b>19,0</b>				
1	Statistics	M	44	3	2,0	2,0	14	10	20			44	x	3			WCY/IMK		
2	Data Centers and HPC Systems	ITT	30	3	2,0	2,0	16		4	10		30	+	3			WCY/ITC		
3	Data Modeling Techniques	ITT	30	3	2,0	2,0	10		20			30	+	3			WCY/ISI		
4	Artificial Intelligence	ITT	30	3	2,0	2,0	10		20			30	+	3			WCY/ISI		
5	Data Mining	ITT	30	3	2,0	2,0	10		20			30	x	3			WCY/ISI		
6	Mathematical Foundations of Data Science	M	44	4	3,0	2,0	22		22			44	x	4			WCY/IMK		
7	Data Analysis and Visualization	ITT	30	4	3,0	2,0	10		20					30	+	4	WCY/ISI		
8	Neural Networks	ITT	30	4	3,0	2,0	10		20					30	x	4	WCY/ISI		
9	Functional Programming	ITT	30	4	3,0	2,0	10		20					30	+	4	WCY/ISI		
10	Virtualization and Cloud Computing	ITT	30	3	2,0	2,0	10		12	8				30	+	3	WCY/ITC		
11	Stochastic Processes in Data Science	M	44	4	3,0	2,0	14	10	20					44	x	4	WCY/IMK		
<b>D. Elective Subjects</b>			<b>254</b>	<b>23,0</b>	<b>15,0</b>	<b>12,0</b>	<b>74</b>		<b>140</b>	<b>40</b>		<b>60</b>	<b>6,0</b>	<b>104</b>	<b>9,0</b>	<b>90</b>	<b>8,0</b>		
1	Data Warehouse Design and Development Data Center Services on Linux Systems	ITT	30	3,0	2,0	1,5	10		20			30	+	3			WCY/ISI WCY/ITC		
2	Database Design and Development - SQL and No-SQL Image Processing	ITT	30	3,0	2,0	1,5	10		20			30	+	3			WCY/ISI WCY/ISI		
3	Graph Mining Data Analytics for Computer Networks	ITT	44	3,0	2,0	1,5	10		24	10				44	x	3	WCY/ISI WCY/ITC		
4	Database Management Systems Detection and Analysis of Computer Network Security Threats	ITT	30	3,0	2,0	1,5	10		20					30	+	3	WCY/ISI WCY/ITC		
5	Machine Learning Windows Services Security in Data Center	ITT	30	3,0	2,0	1,5	10		20					30	+	3	WCY/ISI WCY/ITC		
6	Deep Learning Computer Vision	ITT	30	3,0	2,0	2,0	14		16					30	x	3	WCY/ISI WCY/ITC		
7	Natural Language Processing Application of Cryptography in IT Systems	ITT	30	3,0	2,0	1,5	10		20					30	+	3	WCY/ISI WCY/IMK		
8	Machine Learning - Team Project Data Mining - Team Project	ITT	30	2,0	1,0	1,0				30				30	+	2	WCY/ISI WCY/ISI		
<b>E. Thesis</b>			<b>44</b>	<b>22,0</b>	<b>16,0</b>	<b>11</b>			<b>44</b>		<b>44</b>				<b>44</b>	<b>22</b>			
1	Graduation Seminar Graduation Laboratory	ITT	44	2,0	1,0	1,0					44,0				44,0	+	2	elective	
2	Thesis	ITT		20	15,0	10,0									x	20			
<b>TOTAL NO. OF HOURS / ECTS credits</b>			<b>734</b>	<b>90</b>	<b>61,0</b>	<b>49,0</b>	<b>256</b>	<b>38</b>	<b>382</b>	<b>58</b>	<b>44</b>	<b>312</b>	<b>30,0</b>	<b>288</b>	<b>30,0</b>	<b>134</b>	<b>30,0</b>		
<b>Acceptable deficit of ECTS credits</b>												<b>10</b>		<b>10</b>					
Type and number of required evaluations:												no. of exams x	3		3		2		
												no. of assessments +	8		6		3		

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+48 787 688 168

Warszawa, dn. 13 stycznia 2022 r.

## OPINIA

Dotyczy: Programu studiów na kierunku Data Science.

Wydziałowa Rada Samorządu Studenckiego na posiedzeniu w dniu 12.01.2022 rozpatrzyła pozytywnie program studiów stacjonarnych, II stopnia na kierunku Data Science.



Przedstawiciel RS WCY

Paula Wrzeszykowska





Wojskowa  
Akademia  
Techniczna

Wydział  
Cybernetyki



**Opinia  
Wydziałowej Rady ds. Kształcenia  
Wydziału Cybernetyki Wojskowej Akademii Technicznej**

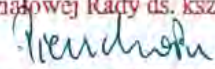
**nr 3/WRdsK/2022 z dnia 5 stycznia 2022 r.**

**w sprawie programu studiów dla kierunku *Data Science***

Na podstawie § 92 ust. 1 pkt. 2 Statutu WAT, stanowiącego załącznik do uchwały Senatu WAT nr 16/WAT/2019 z dnia 25 kwietnia 2019 r. w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego (t.j. obwieszczenie Rektora WAT nr 1/WAT/2021 z dnia 21 października 2021 r.) oraz § 17 ust. 1 pkt. 2 Regulaminu Wydziałowej Rady do spraw Kształcenia Wydziału Cybernetyki Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego postanawia się, co następuje:

**§ 1**

Pozytywnie opiniuje się Program studiów stacjonarnych II stopnia w języku angielskim dla kierunku „Data Science” obowiązujący od roku akademickiego 2022/2023, stanowiący załącznik do niniejszej opinii.

PRZEWODNICZĄCY  
Wydziałowej Rady ds. kształcenia  
  
dr inż. Dariusz PIERZCHAŁA



Wojskowa  
Akademia  
Techniczna

**Uchwała**  
**Rady Dyscypliny Naukowej**  
**Informatyka Techniczna i Telekomunikacja**  
**Wojskowej Akademii Technicznej**  
**im. Jarosława Dąbrowskiego**

**nr 2/RDN ITiT/2022 z dnia 11 stycznia 2022 r.**

**w sprawie zaopiniowania Programu studiów**  
**dla kierunku *Data Science***

Na podstawie § 25 ust. 1 pkt 13 Statutu WAT, stanowiącego załącznik do uchwały Senatu WAT nr 16/WAT/2019 z dnia 25 kwietnia 2019 r. w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego (t.j. obwieszczenie Rektora WAT nr 1/WAT/2021 z dnia 21 października 2021 r.) uchwała się, co następuje:

**§ 1**

Pozytywnie opiniuje się Program studiów stacjonarnych II stopnia w języku angielskim dla kierunku „Data Science” obowiązujący od roku akademickiego 2022/2023, stanowiący załącznik do niniejszej uchwały.

**§ 2**

Uchwała wchodzi w życie z dniem podjęcia.

Prof. dr hab. inż. Andrzej Kozłowski  
Przewodniczący Rady Dyscypliny Naukowej  
Informatyka Techniczna i Telekomunikacja  
Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego  
