Załącznik nr 2
do Uchwały Senatu WAT nr 61/WAT/2025
z dnia 26 czerwca 2025 r.

MILITARY UNIVERSITY OF TECHNOLOGY

Faculty of Civil Engineering and Geodesy

CURRICULUM

Study level second-degree studies

Field of studies: ***geodesy and geoinformatics***

Profile: ***general academic***

Form of studies: ***full-time studies***

Resolution of the Senate of the Military University of Technology
of Jarosław Dąbrowski
No. 61/WAT/2025 of the June 26, 2025

Effective from the academic year 2025/2026

Warsaw
2025

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CURRICULUM
organisational assumptions

for the field of studies: "geodesy and geoinformatics"

Study level **second-degree studies**

Profile: *general academic*

Form of studies: *full-time studies*

Professional degree awarded to graduates: *master of sciences*

Level of the Polish Framework of Qualifications: *7*

The field of studies is assigned to:

Field of science: *engineering and technical sciences*

Discipline: ***Civil engineering, geodesy, and transport. 100%*** *ECTS points*

Major discipline: *Civil engineering, geodesy, and transport*

Language of studies: *English*

Number of semesters: *3*

Total number of hours: *1140*

Number of ECTS points required to complete the studies programme: *90*

Total number of ECTS points to be obtained during lectures and classes:

- **conducted with the direct participation of academic teachers or other instructors – 45,5**
- **in the field of humanities or social sciences – 5**

Duration (number of hours and ECTS points), principles and form of completing the internship:

Each student enrolled in the *geodesy and geoinformatics* degree program is required to complete a professional internship lasting at least **four weeks.** The total number of ECTS credits a student must obtain through the internship is **4 ECTS.**

The internship is an integral part of the learning process in the *geodesy and geoinformatics* program. Its completion is a requirement for passing the academic year. The internship takes place after the first semester.

The rules for completing and passing the professional internship are governed by the Study Regulations of the Military University of Technology named after Jarosław Dąbrowski, as well as by the Rector's Ordinance on the principles of conducting professional internships. Detailed guidelines for the organization and implementation of the internship are provided in the document *"Rules for the Implementation and Completion of Professional Internships at the*

Faculty of Civil Engineering and Geodesy", available on the Faculty's website. The professional internship can be carried out in the following forms:

1. Signing an internship agreement between the university and a host entity, which may be individually selected by the student (individual internship) or arranged by the university (group internship). The host may be an enterprise, institution, government or local administration body, or another organizational unit.
2. Recognition of learning outcomes achieved outside the formal education system, as part of the process of applying for admission to a given field, level, and profile of studies, corresponding to the internship requirements specified in the study program.
3. Participation in a scientific research camp, provided that the nature of the tasks performed corresponds to the internship program.
4. Completion of an individual internship as part of an international exchange or under an agreement between the university and international institutions.
5. Volunteering or internships.
6. Documented individual paid employment.

CHARACTERISTICS OF THE FIELD STUDY

The second-cycle (Master's) degree program in Geodesy and Geoinformatics lasts 1.5 years (three semesters) and is designed for civilian students. It provides a balanced and structured educational path, enabling students to develop competencies progressively—from general technical knowledge to specialized engineering skills. The curriculum begins with core theoretical subjects such as mathematics, physical geodesy, gravimetric geodesy, and geodata processing algorithms, and advances to specialized courses including advanced Python programming, photogrammetric processing, geoinformation system design, geostatistics, engineering photogrammetry, 3D printing in geodesy, and geodata application development. Students also complete general education courses in national defense and occupational safety, as well as language training to achieve at least B2+ proficiency in a foreign language. A key feature of the program is the option to personalize learning through elective courses in the second and third semesters. Practical training is integral, with at least one week of professional internship required. The program concludes with a master's thesis defense, awarding graduates the degree of Master of Science in Engineering and preparing them for doctoral studies and scientific research.

REALIZATION OF STUDIES

The Faculty of Civil Engineering and Geodesy at the Military University of Technology is responsible for delivering the *geodesy and geoinformatics* degree program. The Faculty offers a modern and continuously expanding teaching infrastructure and research facilities, enabling the delivery of innovative and engaging courses as well as the implementation of scientific research in the discipline of civil engineering, geodesy, and transport. The Faculty's resources include two institutes, one department, and an accredited laboratory. Additional laboratories and studios operating within the University are also involved in the teaching

process. The educational buildings are conveniently located on the MUT campus, providing comfortable conditions for studying.

Education in the *geodesy and geoinformatics* program is based on modern infrastructure and current scientific advancements, ensuring a high standard of instruction and practical preparation for careers as surveyors and GIS specialists. Particular emphasis is placed on diverse measurement techniques, including classical methods, satellite (GNSS), photogrammetric techniques, and laser scanning. Students learn to plan, execute, and process geodetic measurements in the context of engineering investments, land and building registry maintenance, as well as monitoring of deformations and displacements.

In the field of geoinformatics, students acquire competencies in the use of Geographic Information Systems (GIS), spatial databases, 3D modeling, and the automation of geodetic processes and spatial analyses.

The curriculum combines a strong theoretical foundation with intensive practical training conducted in modern laboratories, during fieldwork exercises, and through the implementation of engineering projects. Students develop skills in topographic and elevation measurements, geodetic support for construction and infrastructure projects, cartographic elaboration, and processing of data from various sources (GNSS, UAVs, scanners, aerial imagery).

The *geodesy and geoinformatics* program responds to the current demands of the job market and global challenges—such as state digitalization, smart city development, spatial infrastructure, real estate management, and sustainable spatial development. Graduates are well-prepared to work in both public administration and the private sector, in Poland and internationally.

Scientific research conducted at the Faculty plays an important role in shaping the program, enriching the curriculum with the latest technologies and solutions used in geodesy and geoinformatics. A broad range of elective courses allows students to individualize their study paths and pursue their academic interests.

The program includes both team and individual projects, laboratory exercises, and computational classes, providing valuable hands-on experience. Participation in scientific student associations enables the development of original projects using advanced geodetic and GIS equipment and software. For particularly gifted students, there is an option to follow an individual study plan, which helps expand competencies and prepares them for interdisciplinary roles, including in the research and industrial sectors.

PERSONAL AND PROFESSIONAL PROFILE OF A GRADUATE

The graduate possesses advanced theoretical and practical knowledge in the fields of geodesy, geoinformatics, cartography, photogrammetry, remote sensing, and modern measurement technologies, including GNSS, laser scanning, and satellite imaging. They are proficient in methods of acquiring, processing, analyzing, integrating, and visualizing spatial data using specialized software and GIS tools. The graduate is capable of planning and executing complex engineering tasks related to geodetic measurements—topographic, construction, inventory, cadastral—as well as monitoring displacements and deformations. They hold essential skills for supporting construction and infrastructure projects, maintaining land and building records, creating and updating spatial databases, and implementing geographic information systems for public administration and the private sector. During their studies, they acquire

competencies in automating geoinformation processes, programming (e.g., in Python, SQL), 3D modeling, spatial analysis, and handling data from diverse sources: terrestrial, aerial, satellite, and mobile. They understand the significance of spatial data in the context of digital administration, spatial planning, environmental protection, crisis management, and infrastructure development. The graduate is prepared for teamwork, including in interdisciplinary environments, and for independently managing engineering projects with responsibility. They can clearly and accurately present their work using technical language and modern visualization tools. They understand the fundamentals of the geodetic services market and the principles of business operations in this sector. Completing the Geodesy and Geoinformatics program opens broad career opportunities in geodetic companies, design offices, public and local administration, institutions involved in spatial management, cadastre, environmental protection, infrastructure management, as well as in research and development, and companies implementing geospatial technologies. They are also prepared to pursue doctoral studies.

DESCRIPTION OF THE ASSUMED LEARNING OUTCOMES

The description of the assumed learning outcomes includes:

- the universal first-degree characteristics defined in the Annex to the Act of December 22 2015 on the Integrated System of Qualifications
- second-degree characteristics defined in the Annex to the Ordinance of the Minister of Science and Higher Education of November 14 2018 on the second-degree characteristics of learning outcomes for qualifications on levels 6-8 of the Polish Framework of Qualifications, including those that enable obtaining engineer's competences.

and is divided into three categories:

- knowledge (W), which describes the

- scope and depth (**G**) – completeness of the cognitive perspective and relations,
- context (**K**) – conditions and effects.

- the category of skills (U) that defines:

- in terms of the use of knowledge (W) – the problems solved and tasks performed,
- in terms of communication (K) – receiving and formulating utterances, popularising knowledge in the academic environment, and the use of a foreign language,
- in terms of work organisation (O) – planning and teamwork,
- in terms of learning (U) – planning self-development and the development of others.

- the category of social competences (K), which defines:

- in terms of assessment (K) – critical approach,
- in terms of responsibility (O) – the fulfilment of social obligations and acting to support public interest,
- in terms of the professional role (R) – independence and the development of ethos.

Definition of symbols and abbreviations:

- In the column ***code and outcome number:***

- K – learning outcomes:
- W, U, K (underscore) – category: knowledge, skills, social competences;
- 01, 02, 03, … - number of learning outcome.

- in the column ***description element code*** – Inż_P7 _WG – code of the description element of second-degree characteristics for qualifications on level 7 of the Polish Framework of Qualifications.

Code and outcome number	Description of the assumed learning outcomes	Description element code
	KNOWLEDGE The graduate:	
K_W01	He/she has detailed, in-depth knowledge of selected facts and phenomena and of the related theories that explain their complex interrelations and constitute basic general knowledge about social sciences and humanities, their position in the system of sciences and relations to other sciences, including technical ones.	P7S_WG
K_W02	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge, and of the main notions and principles related to the field of studies connected to geoinformatics, geodesy and cartography, spatial management, geoinformatics and navigation.	P7S_WG Inż_P7S_WG
K_W03	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge, and of notions and principles of geodesy, construction, spatial planning. The graduate has an extensive knowledge of the tools and methods related to the acquisition and modelling of geodata.	P7S_WG
K_W04	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge, and of the main notions and principles related to the processing, analysis, and presentation of geodata. The graduate knows typical engineering technologies that enable the realisation of tasks related to geodesy and geoinformatics.	P7S_WG
K_W05	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge, and of the main notions and principles related to the development trends of satellite navigation systems, remote sensing and photogrammetric methods, and geographic information systems.	P7S_WG Inż_P7S_WG
K_W06	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge, and of	P7S_WG Inż_P7S_WG

	the main notions and principles related to the measurement techniques, the life cycle of equipment, structures, and technical systems used in geoinformatics (including geodesy).	
K_W07	He/she has a detailed, extensive knowledge of the methods, techniques, tools, and materials used in solving simple engineering tasks related to engineering geodesy, photogrammetry, remote sensing, GIS/SIT, cartography, and spatial planning.	P7S_WG
K_W08	Understands an in-depth mathematical description of physical phenomena; understands the digital processing of measurement signals; He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge related to mathematics, physics, mathematical cartography, digital processing of measurement signals, advanced methods of observation development, physical geodesy, and other areas in the field of geodesy and cartography that are useful to formulate and solve complex tasks in geodesy and geoinformatics.	P7S_WG
K_W09	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge, and of the main notions and principles related to reference systems, solving geodesic tasks on ellipsoids and spheres, and the gravity field of the Earth.	P7S_WG Inż_P7S_WG
K_W10	He/she has structured, theoretically grounded general knowledge of operating systems and programming techniques. He/she has detailed knowledge of basic specialist software.	P7S_WG Inż_P7S_WG
K_W11	He/she has detailed, extensive, structured, theoretically grounded general knowledge of geoinformatics. He/she has detailed, extensive knowledge of the tools, techniques, and methods of data processing used in geoinformatics, and the methods of processing the acquired data.	P7S_WG
K_W12	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge related to management, including quality management and conducting business activity with respect to preparing studies and providing geodesic and cadastral services.	P7S_WG
K_W13	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced general knowledge of the principles of creating and developing forms of individual entrepreneurship using knowledge related to technical sciences and the discipline of civil engineering, geodesy, and transport that are characteristic of the field of geodesy and geoinformatics; understands the fundamental dilemmas of contemporary economic civilisation, the legal and ethical conditions of different types of professional activity related to the field of study, including the principles of creating and developing various forms of entrepreneurship.	P7S_WG Inż_P7S_WG

K_W14	He/she has a detailed, deep knowledge and understanding of selected facts, objects, and phenomena and the related methods and theories that explain their complex interrelations and constitute advanced knowledge of the basic methods, techniques, tools, and analytical studies used in analysing the displacement of complex engineering structures.	P7S_WG

	SKILLS	**The graduate:**
K_U01	He/she knows a foreign language on the B2+ level of the Common European Framework of Reference for Languages: Learning, Teaching, Assessment (CEFR) and on a higher level as far as specialist terminology is concerned.	P7S_UK
K_U02	He/she has the ability to observe and interpret the surrounding humanist, legal, and social phenomena. Is able to use various techniques to communicate in the professional environment of engineers in the field of “civil engineering, geodesy, and transport”.	P7S_UW
K_U03	He/she is able to prepare a well-documented presentation of problems as well as an oral presentation on the detailed issues related to geodesy and geoinformatics, to present the results of own scientific research in geodesy and/or geoinformatics in the English language and in a foreign language that is considered as primary for the domain of technical sciences and the discipline of civil engineering, geodesy, and transport. He/she is able to prepare and deliver an oral presentation on detailed issues in the field of geodesy and/or geoinformatics in English.	P7S_UW
K_U04	He/she is able to define the directions of further studies and pursue the process of self-educating in order to improve his/her professional competences in geoinformatics (including geodesy, cadastre, cartography, photogrammetry, remote sensing, and information technologies).	P7S_UW
K_U05	He/she is able to obtain information from literature, databases, and other correctly selected sources, also in English language or in another foreign language considered as the language of international communication in the field of geodesy and geoinformatics. He/she is able to integrate and interpret the acquired information, draw conclusions, and formulate and justify opinions.	P7S_UW Inż_P7S_UW
K_U06	He/she is able to use information and communication techniques that are appropriate for the realisation of typical engineering tasks in spatial information systems.	P7S_UW Inż_P7S_UW
K_U07	He/she is able to plan and conduct experiments, including measurements and computer simulations, to interpret the obtained results and to draw conclusions.	P7S_UW Inż_P7S_UW
K_U08	He/she can use analytical, simulation, and experimental methods to formulate and solve engineering tasks.	P7S_UW Inż_P7S_UW

K_U09	He/she is able to prepare for working in a professional environment related to geodesy and geoinformatics and is able to use the principles of occupational safety.	P7S_UW Inż_P7S_UW
K_U10	He/she is able to perform a preliminary economic analysis of the actions taken in the field of geodesy and geoinformatics.	P7S_UW
K_U11	He/she is able to perform a critical analysis of the way of functioning of existing technological solutions, in particular data processing equipment, technologies, and methods, and to assess them in terms of geoinformatics.	P7S_UW Inż_P7S_UW
K_U12	He/she is able to assess the usability of routine methods and measurement tools used to solve a simple, practical engineering task that is characteristic of the field of geodesy and geoinformatics and to choose the correct method and measurement equipment.	P7S_UW Inż_P7S_UW
K_U13	He/she is able to design and perform a simple geodesic measurement task, a system or process of direct and remote sensing measurements, a spatial database, according to the defined specifications, and with the use of the correct methods, techniques, and measurement tools.	P7S_UW Inż_P7S_UW
K_U14	He/she is able to plan and organise individual work and work in a team that performs tasks related to geodesy and geoinformatics.	P7S_UO
	SOCIAL COMPETENCES The graduate:	
K_K01	Is able to cooperate and work in a group, taking on various roles. He/she is aware of the responsibility for own work and is ready to comply with the principles of work in the team and to be responsible for the tasks performed by the team.	P7S_KO
K_K02	He/she is able to set the correct priorities for a task related to geodesy and geoinformatics that He/she has been defined by himself/herself or by others.	P7S_KO
K_K03	He/she correctly notices, identifies, and solves the dilemmas connected to working in the field of geodesy and geoinformatics.	P7S_KO
K_K04	He/she is able to think and act in an entrepreneurial manner with respect to activities in the field of geodesy and geoinformatics.	P7S_KO
K_K05	He/she is able to recognise the social role of a graduate of a technical university. In particular, he/she is able to formulate and communicate to the general public (including by mass media) the information and opinions on technological achievements and other aspects of engineering activities in the field of geodesy and geoinformatics. He/she attempts to communicate such information and opinions in a commonly understandable way. He/she is prepared to fulfil his/her social obligations, to inspire and organise activities for the public interest and social environment.	P7S_KO

Groups of classes/subjects, brief descriptions (syllabi), the assigned ECTS points and learning outcomes (in reference to major-related learning outcomes)

Item	Name of group of courses Course name: Brief description (syllabus)	Number of ECTS points	Discipline code	Reference to major-related outcomes
	Group of general educational content			
1.	***Introduction to national defence:*** Defence-related duties of the State. Preparation of state defence activities, conducting analyses of risks that may lead to crisis situations of a political or military nature, learning about national mobilisation procedures and mobilisation of strategic reserves and preparing the necessary related documentation.	3.0	ILGT	K_W01, K_W02, K_U02, K_U03, K_U04
2.	***Foreign language:*** Structural and grammatical material; revision, extension, and systematisation of the following aspects: grammatical tenses/narrative tenses; active and passive voice; reported speech; conditional sentences; asking questions; collocations; compound sentences; word order in a sentence; modal verbs; phrasal verbs. Vocabulary and communicative material; making requests and suggestions; giving advice; accepting and refusing; denying; agreeing and disagreeing; expressing opinions; cause and effect; purpose and aim; congratulating and apologising; summarising; choosing the appropriate style/register.	2.0	ILGT	K_U01, K_U03
3.	***Occupational health and safety:*** Terms and their definitions: Ergonomics, occupational health and safety, work protection, hazardous, harmful, and onerous factors. Obligations of the employer and the employee. Supervision over the working conditions.	0.0	ILGT	K_W06; K_U18; K_K01, K_K02
	Group of basic courses			
1.	***Mathematics:*** Extended concepts and theorems of mathematics, mathematical analysis, ordinary differential equations, integral calculus of functions of multiple real variables; elements of probability calculus.	3.0	ILGT	K_W08, K_U07, K_U08

2.	***Physical geodesy and geodesic:*** The theory of the gravitational force field of the Earth. Normal gravity field of the Earth. Gravimetric methods of analysing the shape of Earth: the Stokes and Molodensky theories. Contemporary methods of measuring selected parameters that characterise the Earth's field of gravity for the practical purposes of geodesy and Earth sciences. Global and national gravimetric networks: The Basic Gravimetric Network of the State. Using the characteristics of the gravity force field in preparing geodesic measurements for engineering purposes.	2.0	ILGT	K_W02, K_W04, K_W08, K_W09, K_U06
3.	***Geodata processing algorithms:*** Characteristics of the algorithm: Organisation, definite and finite number of operations and a finite time of completion. Classification of algorithms based on their construction method, the manner and sequence of performing operations. Iterative and recurrent algorithms. Simple algorithms: search and sorting algorithms. Algorithms and numerical methods used in geodesy and geoinformatics. Minimalist methods algorithms, mapping algorithms, fILGTering algorithms. Greedy algorithms, e.g., Dijkstra algorithm (searching the shortest route from the specified vertex of a graph).	2.0	ILGT	K_W04, K_W11, K_U06, K_U11, K_U13, K_U14, K_K02
	Group of general educational content			
1.	***Satellite measurement techniques:*** Earth observation techniques utilised by specialised space missions or surveying modules placed in extra-terrestrial space. Planning GPS (Global Positioning System) observations. Designing GNSS (Global Navigation Satellite System) satellite networks. Selecting a GNSS measurement site, creating a schedule of observations. Strategies of performing GNSS observations. Types of GNSS antennas - phase centre, multipath signal problem. Preparing GPS satellite observations. Differences in GNSS observations, linear combinations of phase and code observations. Possibilities to use linear combinations of phase observations. Advanced methods of processing GNSS observations. The GLONASS (GLObal NAvigation Satellite System) – functional description. Similarities and differences between GPS and GLONASS. Joint use of the GPS and GLONASS systems. Other existing and planned satellite systems: GNSS (Global Navigation Satellite System), EGNOS (European Geostationary Navigation Overlay Service), Galileo, DORIS (Digitales Oberösterreichisches Raum-Informations-System), PRARE (Precise Range And Range-Rate Equipment). Global, regional, and national satellite geodynamic networks.	3.0	ILGT	K_W08, K_W09, K_W11, K_U04, K_U05, K_U10, K_U14, K_K01

2.	***Programming in Python – advanced level:*** The differences between Python 2.x and Python 3.x. Procedural and object-based programming. Handling exceptions. Organising the code into modules and packages. Structure of the project. Virtual environment. Standard python libraries: Regular expressions, command line parameter handling (argparse), date and time. Debugging and testing the code. Web applications (Django framework, Flask module). Data analysis and visualisation in the pandas and matplotlib libraries. Good practices PEP8, idiomatic solutions used in Python.	2.0	ILGT	K_W02, K_W04, K_U11
3.	***Reference systems in geodesy:*** Reference system and regimen, set of coordinates, geodesic base of reference. Terrestrial and celestial reference systems. Transformation between the terrestrial and celestial system. Dynamics of the rotational and circular movement of the Earth. Precession, nutation, and polar movement. Parameters of the rotational movement of the Earth and their role in the transformation of reference systems. Times. The notion of height in geodesy. Height systems. Reference systems that are binding in Poland. Transformation between ITRF and ETRF. Methods of realisation of the reference systems: GNSS, VLBI, SLR, LLR, and DORIS.	2.0	ILGT	K_W08, K_W09, K_U01, K_U03, K_U04, K_U05, K_U11
4.	***Advanced photogrammetric studies:*** The course presents topics related to advanced situational and altitudinal, inventory and design studies that are created with use of contemporary photogrammetric methods and digital image processing based on the synergy of data acquired at various altitudes. The selection and scope of educational content focuses on the ability to use photogrammetric imagery acquired at various altitudes and with various sensors to create typical photogrammetric studies that require comprehensive spatial mapping including all aspects related to the completeness and accuracy of the product, as well as atypical studies that result from recreating 3D spaces in various time references and contemporary studies with atypical configuration of source data and objects of a complex structure and difficult position.	2.0	ILGT	K_W02, K_W04, K_W05, K_U01, K_U03, K_U05, K_U08, K_U12, K_K01
5.	***Designing geographic information systems:*** Methodology of designing IT systems and the tools and techniques for the implementation of geographic information systems. Methodologies and software that are used to manage an IT project. Basics of UML. OMG specifications, OGC standards, and ISO 19100 standards. Analysis of object-based and structural methods.	2.0	ILGT	K_W03, K_W12, K_U02, K_U07, K_U10, K_U13, K_K01

6.	***Publishing geospatial data:*** European and Polish infrastructure of spatial information. Legal and technical aspects of publishing spatial data. The role of metadata in publishing data and spatial data services. Geoportals and archives of spatial data. Standards of services related to geospatial data. Types of customers of such services. Interoperability, harmonisation and integration of spatial data sets.	3.0	ILGT	K_W03, K_U04, K_U06, K_U08, K_U11, K_K01
	Group of major-related educational content			
1.	***Diagnostic measurement of objects:*** Geodesic surveys in diagnostic investment processes. Interpretation of tension, deformation, displacement, and border states. The reasons for the emergence of displacements and deformations. Specificity of geodesic measurement of displacement. Determination of vertical displacement based on precision levelling measurements. Determination of horizontal displacements – incomplete trigonometric network, complete trigonometric network, angular-linear network, the constant straight-line method. Geodesic interpretation of the results of displacement measurements. Methods of measuring relative displacements. Automated measuring of displacement and deformation – monitoring. Selected method of processing the results of displacement measurements – static and kinematic models.	4.0	ILGT	K_W06, K_W08, K_W12, K_W14, K_U02, K_U07, K_U10, K_U12, K_U14, K_K01
2.	***Advanced methods of processing observations:*** Numerical methods of processing observations that are used in practice and are related to different variants of processing and analysing geodesic information in form of numerical maps, images, and geodesic networks. Techniques of creating models of observations that reflect their temporal and spatial distributions based on the algorithms of script languages: Octave, Matlab, R, and Phyton. Modified least squares methods that are necessary to solve tasks that take into consideration the mechanisms of resistance to gross errors of observation.	5.0	ILGT	K_W09, K_W11, K_W14, K_U04
3.	***Advanced satellite observation techniques:*** Close-range photogrammetry. Terrestrial imaging techniques in the visible range. Analogue and digital terrestrial photogrammetric cameras and the adaptation of non-metric digital cameras for the tasks of engineering and industrial photogrammetry as an alternative for the technology of geodesic surveys, including laser scanning. Unmanned aerial vehicles used to acquire imagery that enables spatial modelling of close-range objects and their surroundings.	5.0	ILGT	K_W05, K_W08, K_U08, K_U11, K_U13, K_U14

4.	***Terrestrial and low-altitude scanning:*** Acquiring and processing data with the use of laser scanning techniques (stationary and mobile ground scanners and scanners installed on UAVs). Data analysis, knowledge and realisation of the whole data processing process from the acquisition of measurement data to processing the results in specialist software.	5.0	ILGT	K_W05, K_W08, K_U03, K_U04, K_U05, K_U10, K_U12, K_K01, K_K02
5.	***Mobile measurement systems:*** Specificity and importance of mobile systems. The structure, software, and organisation of Mobile Mapping Technology (MMT). Mobile mapping system. Integration of mobile technologies based on economic objectives. Specificity of mobile CAD systems for the measurement of buildings. Mobile railway measurement systems. Mobile road and mining systems. Measurement systems on vessels. Satellite and terrestrial ground penetrating radar imagery. GPR measurement methods.	5.0	ILGT	K_W02, K_W04, K_W14, K_U01, K_U03, K_U08, K_U09, K_U10, K_K04
6.	***Legal conditions for geodesic surveys:*** Geodesic and legal processes. Geodesic documentation as an element of geodesic operations in the light of binding regulations. Main legal acts that lay down the principles for preparing and compiling documentation for typical geodesic works. Technical standards for closed areas. Geodesic and legal processes in closed and restricted areas. Legal conditions for the geodesic services for investments. Conditions related to spatial planning and development.	5.0	ILGT	K_W07, K_W11, K_W12, K_U03, K_U05
7.	***Automation of geodesic surveys:*** The nature of the revolutionary changes in geodesy that started in the last decade of the 20th century. Links between geodesy and information technology. Measuring systems - electro-optical rangefinders, robotic total stations, and digital levellers. Operational and functional software of measurement systems. Industrial measurement systems. Global Satellite Navigation Systems. Ground photogrammetric measurement systems. Telemetric measurements. The prospects for machine learning and artificial intelligence in measurement automation.	5.0	ILGT	K_W06, K_W10, K_U06, K_U08, K_U13, K_K01, K_K02
8.	***Automation of geoprocessing systems:*** Programming in a GIS (Geographic Information Systems) environment, focused on the automation of spatial data processing. Basic terms and selected functions of the Python language in the most commonly used GIS software packages (ArcGIS, QuantumGIS). Automation with Model Builder.	5.0	ILGT	K_W10, K_W11, K_U04, K_U07, K_K02

9.	***Geostatistics:*** Theoretical and practical aspects of geostatistics. Tobler's laws, spatial autocorrelation, conditions for the application of geostatistics, the notions: Regionalised variable, variogram, covariance, kriging. Selected examples of geostatistics, including in creating real property valuation maps.	5.0	ILGT	K_W09, K_U06, K_U08, K_U11
10.	***Cadastral information systems:*** Definition and evolution of cadastral information systems, from fiscal cadastre to multi-function and multi-dimensional cadastre and land administration system, the "iLand" and "Butterfly" concepts. ISO 19152:2018 Geographic information — Land Administration Domain Model (LADM). The role of the International Federation of Surveyors (FIG) in shaping the development of cadastral systems. Cadastre in Poland: legal basis, current state, ZSIN (Integrated Real Property Information System), the objectives of 3D cadastre. Automated property valuation, real property valuation maps.	5.0	ILGT	K_W07, K_W12, K_U04, K_U11, K_U12
11.	***Artificial Intelligence and machine learning in processing geodata:*** Processing photogrammetric remote sensing, panchromatic, multispectral images with the use of AI, including machine learning. Selecting algorithms and tools to solve a specific task and the ability to use specialist artificial intelligence software for professional digital processing. Interpretation and assessment of the obtained results.	5.0	ILGT	K_W07, K_W10, K_W14, K_U04, K_U08, K_U12
12.	***Deep neural networks in the analysis of geodata:*** Processing geodata with the use of deep neural networks. Selecting algorithms and tools to solve a specific task and the ability to use specialist artificial intelligence software for professional digital processing. Assessment and optimisation of the developed models. Interpretation of the results obtained with the use of trained models.	5.0	ILGT	K_W07, K_W10, K_W14, K_U04, K_U08, K_U09, K_U12
13.	***Photogrammetry in engineering:*** Preparing and processing geodata for civil engineering tasks. Preparing measurement data, including the acquisition and pre-processing to the form of complete point clouds and Numerical Model of the Object. Using point clouds for various tasks related to geospatial engineering with the use of photogrammetric and remote sensing data.	4.0	ILGT	K_W05, K_W08, K_W09, K_W14, K_K01
14.	***Global geodesic networks:*** The role of global geodesic networks in the realisation and maintenance of reference systems, monitoring geophysical phenomena that occur on the surface of the Earth and in the atmosphere, and supporting selected tasks performed by civil services. Infrastructural issues, including types of measurement equipment and the	5.0	ILGT	K_W05, K_W08, K_W09, K_W14, K_K01

	ways of accessing observation data and processed data. Spatial analysis of basic data and maps provided by local and global centres and independent processing of GNSS data of various degrees of sampling.			
15.	***3D and BIM modelling:*** Preparing and processing geodata in the process of modelling building information. Preparing measurement data, including the acquisition and pre-processing to the form of complete clouds of points. Creating a 3D model of a building in specialist software. Acquiring accurate and coordinated data directly from the BIM model through modern total stations and their digital replication at the construction site.	4.0	ILGT	K_W03, K_W07, K_W10, K_U02, K_U03, K_U06, K_U11, K_U14, K_K01
16.	***Automated editing of maps and analyses*:** The application of GIS systems for processing topographic maps. Editing and symbolisation of map content elements. Mapping data between DLM and DCM schemes. Generalisation of data. Automation of geospatial analyses with the use of ETL tools.	4.0	ILGT	K_W05, K_W11, K_U02, K_U05, K_U09, K_U11, K_U14, K_K02
17.	***3D printing in geodesy and cartography*:** The application of incremental creation in geodesy and cartography. Creating physical, cartometric 3D maps. Specificity of various printing techniques (parameters, materials, capacity), 3D modelling for printing, service and operation of printers.	4.0	ILGT	K_W02, K_U04, K_U06, K_U09, K_U10, K_U13
18.	***Virtual and augmented reality in geodesy:*** Source data for 3D visualisations. Properties and applications of Augmented Reality and Virtual Reality. Types of applications for augmented reality. Spatial and mixed augmented reality (SAR, MR). Platforms and applications for creating VR/AR/SAR/MR.	4,0	ILGT	K_W03, K_W10, K_U04, K_U11, K_U13
19.	**Programming applications for geodata:** Structure of online applications and data publishing services, including spatial data publishing. Programming web applications and simple websites, presentation of the issues related to creating and writing scripts that perform CRUD, REST API operations. Web technologies in designing a simple web page: HTML, JavaScript, and PHP. Presentation of existing geoportals and the provided data publication services: WFS, WMS, WCS. Creating a thematic geoportal, installation and configuration methods.	4,0	ILGT	K_W03, K_W11, K_U02, K_U04, K_U07, K_U08, K_K02
	Course contents: ***Dissertation***			
1.	***Diploma seminars:*** Preparation for the selection of the topic and starting the dissertation; considering various types of diploma dissertations depending on their objective and subject; Topics of dissertations, ethics and techniques, the role and	4.0	ILGT	K_W13, K_U02, K_U03, K_U05

	manner of using technical literature in solving technical problems, the role of experiment; elements of copyright law; stages of solving and realising the set task; the layout and content of the dissertation; presentation and discussion of the ways to solve the issues included in the set task, partial results, and the dissertation as a whole.			
2.	***Dissertation:*** Preparing a diploma project related to the field of geoinformatics with the elements of scientific research. The analysis of the problem presented in the dissertation should take into consideration information from literature in foreign language.	20.0	ILGT	K_W13, K_K03, K_K04, K_K05
	Course contents: ***Internships***			
1.	***Internships:*** Acquiring knowledge and improving skills related to geoinformatics, including processing of the acquired data and preparing final products that are typical for geodesic works and the analysis of geodata.	4.0	ILGT	K_W06, K_W08, K_W12, K_W14, K_U02, K_U07, K_U10, K_U12, K_U14, K_K01
	Total:	90		

METHODS OF VERIFICATION AND ASSESSMENT OF THE LEARNING OUTCOMES ACHIEVED BY THE STUDENT THROUGHOUT THE CYCLE OF EDUCATION

The defined major-related learning outcomes are verified systematically. In order to receive credit for each of the courses, the student has to receive a passing grade in one of the following regimens: examination, graded test or general grade test. In order for the student to be promoted to subsequent semesters of major-related and specialist studies, the student has to pass all courses in the relevant field and receive 30 ECTS points. The student may be promoted to the subsequent semester conditionally, within the limit of the acceptable ECTS score deficit that is defined in the plan of studies. However, the outstanding courses must be limited to the current semester and the preceding semester. Moreover, during the semester students take part in written tests, auditorial classes, which are assessed, as well as the contribution to discussions or active participation during classes.

Passing grades for practical laboratory and project courses are awarded based on the results obtained in specific preparatory classes, homework assignments, calculation tasks, and longer written works, such as reports, passing (defending) the prepared projects in compliance with the rules of the internal system of ensuring the quality of education. detailed grading criteria for all courses are provided in the information charts of the courses.

In order to be accepted to participate in a final test or examination, the student must complete all forms of realisation (projects, homework assignments) in compliance with the rules of the internal system of ensuring the quality of education. In order to receive a passing grade for a course the student must perform all laboratory and calculation exercises foreseen in the curriculum and pass them (in the event of justified absence from class, the teacher is obliged to offer the student a possibility to perform a maximum of two instrumental exercises during consultations). The student must also pass all the mandatory written or oral tests.

In order to receive a passing grade, the student must receive a 60% score. The W and K outcomes are tested: during the examination or final test of the course. The U outcomes are tested based on the grades obtained for specific preparatory exercises, homework assignments, calculation exercises, and longer written works in form of reports or defence of homework assignment projects. The knowledge and skills related to practical specialist education will be verified during professional internships, where students have to demonstrate practical knowledge of the issues connected to geodesic works.

Detailed information about the verification of the planned learning outcomes of specific courses and modules is provided in the information charts of the modules and presented to students at the initial stage of learning, as well as in the USOS system of the faculty, in compliance with the rules of the internal system of ensuring the quality of education. The final verification of the acquired knowledge and skills is the diploma exam, which tests: the ability to solve problems related to geodesy and geoinformatics. In order to be accepted to take the diploma examination, the student must pass all general, major-related, and specialist courses and prepare a dissertation that is then positively assessed by the supervisor and reviewer.