Second-cycle studies programme with hours/week in three semesters [15 weeks]
Field of education: Geodesy and Cartography, specialization Engineering and Industrial Surveying

No	Course	Sem. I				Sem. II				Sem. III			
	l - lecture, e - exercices, p - project, E - exam	l	e	p	ECTS	l	e	p	ECTS	l	e	p	ECTS
	General courses												
1	Selected Topics of Economic Law	1			1								
2	General course					1			2				
3	Geodetic and Cartographic Law									1	1		2
4	Specialized language (level B2+)										2		1
	General courses for profiles A and B												
5	Mathematics		2		3								
6	Selected Topics of Mathematics and Numerical Methods	1	2		4								
7	Geophysics	1	1		2								
8	Selected Topics of Physical Geodesy and Geodynamic			1	2								
9	Digital Image Processing			2	2								
	General and shared courses for all specializations of the profile A (geodetic)												
10	Standards in Geographic Information	1			2								
11	Geodetic Frames in Geodesy			1	2								
12	Space Geodetic Techniques	1		2	3								
13	Engineering Surveying	1		1	3								
14	Geodetic Service of the Construction Process	1		1	2								
15	Surveying Studies for Legal Purposes	2		2	4								
16	Facultative class 1 (from profile A)					2			1				
17	Facultative class 2 (from profile B)					1		1	2				
18	Facultative class 3 (from profile A)					2			1				
19	Facultative class 4 (from profile B)					2			1				
	Specialization courses for Engineering and Industrial Surveying												
20	Urban Geodesy					1		1	3				
21	Special Measurements in Engineering Geodesy					2		1	3				
22	Survey System Design					1		2	3				
23	Mathematical Models for Displacement Surveys									1		1	3
24	Measurements of Displacements and Deformation Analysis					1		1	3				
25	Seminar on Measurements of Displacements										2		1
26	Engineering Surveying Seminar						2		1				
27	Fieldwork in Engineering Geodesy							1	2				
28	Surveying investment management									1		1	2
29	Mechanics of Structures and Constructions					1			2				
30	Engineering Facilities Information Systems							2	2				
31	Analyses of Measuring Networks – Concepts and Methods					2		1	4				
32	Diploma seminar										2		1
33	Graduation work (thesis)												20
	TOTAL	9	5	10	30	16	2	10	30	3	7	2	30

Description of the courses

General courses	
Selected issues of economy law	1. Basic information on economic law 2. Sources of law, including the economic law 3. Legal entities. an individual and a legal person, methods of their creation and their legal capacity. 4. The principles of representation of legal persons. 5. Basics principles of obligation. Contracts as a source of obligations. The principle of freedom of contracts. Modes of concluding a contract, in particular in the economy. 6. The principles of fulfillment of contractual obligations. Consequences of non-performance or improper performance of the contract. 7. Taking up and running a business. The concept of the entrepreneur. Forms of runnning and requirements for starting a business. 8. Economic freedom and its limitation 9. Registration of running of an individual entrepreneur in the Central Register of Economic Activity, Polish Classification of Economic Activity 10. Company law. Principles of establishing companies. Register of Entrepreneurs of the National Court Register 11. Partnerships and capital companies – main features

Geodetic and Cartographic Law	Lecture: Tasks of the organs of the geodetic and cartographic service. State geodetic and cartographic repository – management, sharing, fees, licenses. Submission of geodetic and cartographic works. Coordination of utilities network projects. Protection of geodetic controls. Geodetic works in closed areas. Technical standards applicable in surveying. Rules for completing technical reports. Professional qualifications in the field of geodesy and cartography. Exercises: Preparation of a geodetic work application. Preparation of a fee calculation document for materials for the submitted geodetic work, drawing up a license for the above-mentioned geodetic and cartographic materials. Preparation of a technical report for the submitted work and the content of the technical report for a specific assortment of surveying work. Preparation of an application for authentication of geodetic materials resulting from surveying work. Preparation of a notice of completed surveying work. Preparation of an application for coordination of the utilities network project.
Specialist foreign language	Achieving the B2+ level of knowledge of a foreign language by expanding the specialist vocabulary related to geodesy and cartography and improving other skills that will enable students to communicate freely in a foreign language, prepare effective presentations and write an abstract of a master's thesis, report or texts in a foreign language useful in their professional work.
Mathematics	Functions of complex variable: function derivative, Cauchy-Riemann equations, holomorfic function. Integration of complex function, Cauchy integral theorem, Cauchy integral formula, Laurent series, residual of the complex function and its application for the computation of integrals. Basic equations of mathematical physics. Partial differential equations of the first and second order and their classification. Differential equations of the string and of the thermal conductivity. Fourier method of the separation of variables. Integration and ultra-tight (deep) integration.
Selected Topics of Mathematics and Numerical Methods	The main purpose of the course is to give students theoretical and practical knowledge on the selected methods of random signals analysis. The course will present mathematical background and describe algorithms of empirical data analysis, both in the time and frequency domain. The course will begin with a short introduction to the theory of probability, random variables and their parameters. Next, given is description of the random signals with special attention paid to the properties of stationarity and ergodicity. The basic characteristics of the signals are introduced: mean value and variance, probability density, autocorrelation and power spectral density (PSD) functions, then the joint characteristics: joint probability density, cross correlation and the cross power spectral density (CPSD). The data analysis algorithms will include the classical methods, based on the digital Fourier transform, and the parametric methods focusing on the autoregressive (AR) modeling of time series. The last part of the course is devoted to the application of the linear Kalman filter to the time domain analysis of discrete data. It begins with definition of the linear dynamical system using the state-space formulation, then the filtering equations are derived. The project part of the course includes application of the computer programs for analysis of empirical data.
Geophysics	The purpose of this course is to give the students a basic knowledge on the folowing subjects: The Earth as a planet. Internal structure of the Earth. Isostasy – postglacial rebound. Plate tectonics: oceanic rifts, subduction zones, orogens, transform boundary. Rheology. Seismology: seismic waves, seismic wave propagation, Richter scale. Earth's magnetic field: parameters, units, constituents, geodynamo hypothesis. Magnetic surveying: magnetic anomalies. Geomagnetic poles, equator and coordinates (calculation of). Paleomagnetism, polarity reversals. Magnetosphere, magnetic storms and solar activity. Hydrological cycle, physical properties (density, optical, acoustic) of oceanic water. Physical oceanography: thermocline, waves, currents, deep-water circulation, oceanic tides. Basic of fluid dynamics. Particular attention is paid to the interactions between geophysics and geodesy. That includes those geophysical theories and models which are used in geodetic practice, as well as the geodetic observations and models which can support geophysical research.

Selected Topics of Physical Geodesy and Geodynamics	Gravimetric measurements - construction of a gravimeter, preparation for measurement (calibration, adjustment) - calculation exercise: determination of the gravimetric factor from measurements on a calibration basis. Gravimetric measurements - Development of a gravimetric measurement with the calculation of the tidal correction - calculation exercise: preparation of the results of a gravimetric span measurements with relative method. Gravimetric measurements - development of measurement results: calculation of the field correction, calculation of reductions and gravimetric anomalies - calculation exercise: preparation of a map of free air anomalies and the full Bouguer anomaly.
	Tidal deformations - determination of the deformation of the earth's crust caused by tidal phenomena, static and dynamic tidal model - computational exercise: determination of the deformation of the earth's crust in the neu system for a specific point in a given period. Non-tidal deformations - determination of deformations caused by non-tidal phenomena (atmosphere, hydrology or anthropogenic and local factors) - computational exercise: determination of the Earth's crust deformation in the neu system for a specific point. Implementation of the EVRF2007 system - determination of the increments of geopotential number with the use of real gravimetric measurements and geopotential models - accuracy analysis - computational exercise: determining the increments of geopotential features for a selected leveling line, reduction to zero tide. The phenomenon of isostasy and its importance for the implementation of the geodetic network - computational exercise: modeling of the isostatic effect on the basis of the GNSS time series (Fennoscandia). Gravity field of simple geometric solids - elements of geophysical interpretation - computational exercise: modeling of gravity field anomalies resulting from anomalies of subsurface formations. Elements of the gravity field in connecting the natural (related to the plumb line) and geodetic (related to the normal line) coordinate system - computational exercise: reduction of traverse elements from the tacheometric system to the geodetic system related to the GNSS network.
Digital image processing	1. Registration and development of a digital image 2. Digital image recording formats. 3. Lossy and lossless image compression methods. 4. Basics of image processing in Matlab (Computer Vision System Toolbox TM) 5. Basics of image processing in Python 6. Preprocessing (Matlab) and automatic image vectorization (ArcGIS) 7. Detection and analysis of text on images using the function Optical Character Recognition (OCR) 8. Clustering algorithms and the basics of machine learning for digital image classification. 9. Contextual processing: removing noise from an image through selected low-pass filters and detection characteristic elements of the image through high pass filters 10. Basics of mathematical morphology. 11. Basics of image texture analysis: fractal analysis, GLCM, granulometric analysis.
General courses	
Standards in Geographic Information	Lectures: 1. Concepts of standard and norms. Objectives and tasks of standardization. 2. The subject, structure, and organization of standardization in GI. OGC standards, ISO standards. 3. Standards formalism, ISO / TS 19103 specification - UML language and ISO 19109 - rules of application schemas. 4. Selected issues from the ISO 19100 series standards: - describing the position (ISO 19107, ISO 19125-1, ISO 19111 and ISO 19112); - temporal scheme (ISO 19108); - data quality (ISO 19157 and ISO 19158); - cataloging methodology (ISO 19110); - metadata (ISO 19115); - XML language - GML (ISO 19136 and ISO 19139). 5. Rules for the use of standards in specific applications.
Geodetic frames in geodesy	The content of the exercises: 1. Estimation of a station velocity on the basis of position time series - introducing discontinuities - estimation of seasonal terms - detection of outliers 2. Extrapolation of coordinates to the desired epoch 3. Transformation of coordinates between two terrestrial reference systems 4. Estimation of station velocities using plate tectonics models 5. Estimation of plate rotation pole on the basis of GNSS velocity field. Estimation of intraplate velocities.

	Space Geodetic Techniques	Geodetic satellites, classification and history. Equations of motions of satellites The role of atmosphere in satellite geodesy GNSS: GPS, GLONASS, Galileo - error sources, classification - atmospheric effects: ionosphere, troposphere. - antenna phase center variations. Multipath. - differences of observation, linear combinations - GNSS data processing in regional networks SLR and DORIS satellite techniques VLBI - space geodetic technique Satelite altimetry and its missions Earth gravity field. CHAMP, GRACE, GOCE missions. Reference frames realized by space geodetic techniques: ITRS/ITRF. Space geodetic techniques services : IGS, EUREF, ILRS, IDS, IVS. GGOS.Applications of space geodetic techniques in geodynamics
	Engineering Surveying	Lectures: Geodetic measurements for construction service and operation control of the railways (4 hours), Specialistic techniques of industrial measurements (autocollimation of parallel and convergent light rays, autoreflection (5 hours), Control measurements of rotary kilns (2 hours), Surveying tasks in underground construction and mining (2 hours), Measurement of unstable objects on the example of shipbuilding (1 hour), Measurements of the special objects. Measurements on the closed areas - excluded from local government administration (1 hour). Project exercises: Measurement and development of the reconstruction project on the example of a railway section (5 hours), Development of the tunnel construction measurements service project (4 hours.), Autocollimation measurements: azimuth transfer in the two-level network, direction transfer through the obstacle (6 hours).
	Geodetic Service of the Construction Process	1. The process of preparing a construction investment (maps for design purposes, supplementary measurements, field interview in the field of finding technical equipment for the area. 2. GESUT. 3. Local Development Plan and Decision on development conditions. 4. Plot development plan, preparation for applying for a building permit. 5. Workplaces for realization of various building objects (formal and technical basics). 6. Geodetic elaboration of a construction project. 7. Object location staking. 8. Building and assembly control systems in servicing the construction of an industrial and residential facility. 9. Geodetic measurement techniques used at various stages of construction implementation. 10. Control measurements of assembly elements and structures. 11. As-built acceptance. 12. Regulations and standards for the measurement of premises' area.
	Surveying studies for legal purposes	Lecture: Surveying procedures and documentation prepared for the purposes of administrative and court proceedings and surveying works related to the determination of the course of boundary lines and location of crossing points. Real estate delimitations – surveying procedures and documentation, criteria of determination of the course of boundaries, and types of resolutions of administrative and court proceedings. Real estate divisions – surveying procedures and documentation – administrative proceedings (act on real estate management and special acts concerning regulation of legal statuses of public roads and railway areas; court proceedings and divisions of agricultural and forest real estate. Land consolidation (surveying procedure and documentation). Land consolidation and division (surveying procedure and documentation). Land usucaption. Land easements. Delineations of real estate covered with surface waters. Renewal of boundary marks and designation of boundary marks (surveying procedures and documentation, rules of use of archival materials and accuracy of determination of coordinates of boundary marks). Determination of the course of boundaries of registered plots (surveying procedure and documentation, criteria of the course of boundary lines). Design practice: preparation of selected documents – maps, directories, and registers, and other studies included in technical reports.
	Facultative class 1 - Review of contemporary surveying techniques	The principles of operation of selected measurement systems and the conditions for the use of individual measurement techniques in measurement implementation procedures and methods of determining displacements will be presented. A report will be made on the measurements made by videotachimeter. During the project implementation, the student will use the GNSS signal generator 1. statistical analysis of the measured time series 2. filtering with the use of a moving average and a median filter in a given filtering window 3. Fourier analysis of recorded time series 4. making appropriate charts 5. execution of the report

	Facultative class 1 - Advanced use of Matlab in geodetic and cartographic calculations	The principles of operation of selected measurement systems and the conditions for the use of individual measurement techniques in measurement implementation procedures and methods of determining displacements will be presented. A report will be made on the measurements made by videotachimeter. During the project implementation, the student will use the GNSS signal generator 1. statistical analysis of the measured time series 2. filtering with the use of a moving average and a median filter in a given filtering window 3. Fourier analysis of recorded time series 4. making appropriate charts 5. execution of the report
	Facultative class 2 - Spatial data mining	Introduction to Spatial Data Mining. Data preprocessing and spatial data enrichment. Non-classical logics, including fuzzy logic. Rough sets and reducts. Decision trees. Association rules. Spatial concentration analyses. Spatio-temporal trends. Text mining and Twitter spatial data analysis. Big Data. Distributed databases. Distributed data processing
	Facultative class 3 - BIM in investment management	Lectures: BIM Standards and Initiatives; BIM Guides and Execution Planning; Uses of BIM; Levels of BIM; Impact of BIM; The Evolution to Object-Based Parametric Modeling; Parametric Modeling of Buildings; Creating a model based on a point cloud; BIM Environments, Platforms, and Tools Overview of the Major BIM Design Platforms; BIM for Owners and Facility Managers; BEP, Scope of Design Services; BIM Use in Design Processes; BIM for Contractors; Processes to Develop a Contractor Building Information Model; Construction Analysis and Planning; Integration with Cost and Schedule Control and Other Management Functions.
	Facultative class 4 - Machine Learning	1. Introduction to the class. Basic information on unmanned aerial vehicles 2. Legal provisions regarding the use of UAV aviation law 3. Review of photogrammetric UAV platforms and RGB, NIR, multispectral, hyperspectral, LIDAR sensors 4. Planning and development of photogrammetirc missions with the use of UAV 5. Processing of photogrammetric data obtained from the UAV 6. Regulations in the field of geodesy and cartography regarding the use of data from UAV platforms 7. Presentations of exemplary geodetic works using UAV data
	Facultative class 4 - UAV Technologies	Lectures: 1. Introduction to Machine Learning, basic concepts 2. Supervised and unsupervised learning 3. Classification 4. Regression 5. Cluster analysis: hierarchical, k-means, c-means, Kohonen networks 6. Supervised methods: kNN, least distance, maximum likelihood, decision trees, random forests, SVM, Bayes classifier 7. Artificial neural networks: neuron model, multilayer perceptron 8. Training of multilayer perceptron, mathematical model of a neuron 9. Deep neural networks, convolutional neural networks 10. Practical aspects of Machine Learning application in remote sensing 11. Typical problems in Machine Learning: small amount of data, unreliable data, unrepresentative data, overfitting, etc. 12. Methods of increasing model accuracy: extending a set of image features, knowledge transfer from related problems, combined methods 13. Machine learning in time series applications: trend curve fitting, outlier detection, prediction by analytical methods and deep networks (LSTM) 14. Competitive learning and other new trends in Machine Learning, examples of Machine Learning applications in remote sensing and related fields
Specialization courses		
	Urban geodesy	Urban maps: basic urban map, thematic maps, updating the basic map, supplementary measurements, terrain profiles, map for design purposes. Geodetic services for spatial development plans in urban areas. Metro as an underground structure: - designing and setting out reference points, - construction and geodetic services of guiding the TBM, - tunnel shape control during and after construction, - deformation monitoring, - operational measurements.

		Geodetic issues in land management. Preparation of special and thematic maps for the city area. Geodetic control networks: horizontal basic control networks, detailed control networks, height control networks - characteristics of the basic control network for the city. Reference networks for streets, communication routes, railway stations, construction sites, bridges and other engineering facilities. Stabilization systems for urban reference networks. Methods of establishing wall-mounted reference points. Map for legal purposes. Regulations and rules for the preparation of design and executive studies. Geodetic spatial development of the surface of an urbanized area: designing the topography of urban areas, squares and streets. Performing analytical and graphic studies for volume calculations in urbanized areas. Surveying services for the construction of residential investments using various techniques (from the classical method through the industrial to the sliding method). Construction and assembly of control systems for civil structures. Surveying techniques in civil engineering services. Laser and code levels, laser and ultrasonic rangefinders, plane and direction projectors, laser and optical plummets, precise inclinometers as the instruments for providing geodetic services in civil engineering. Road structures, bridges and viaducts in urban areas, geodetic works at the design and implementation stage. Spatial development of route axes - vertical curves. Detection and design of underground utilities using direct and indirect techniques. Designing the arrangement of technical equipment in the cross-section of the street GESUT as a system for collecting data on technical infrastructure.
	Special Measurements in Engineering Geodesy	Lecture: The methodology and specificity of the accuracy requirements for measurements performed with the technique of terrestrial laser scanning for the purpose of assessing the condition of the object, in particular testing the deformation of the surface and structure of the object. Examples of the use of terrestrial laser scanning in engineering geodesy: construction, hydraulic engineering, rail communication, mining. Geodetic measurements performed during the service and inspection of the condition and displacement of sheet piling, diaphragm walls and anti-filter screens. Application of terrestrial laser scanning in the inventory of machines and industrial halls. Selected departments of geodetic service of road and bridge construction: technical standards, geodetic service of individual construction stages, control measurements, application of GNNS techniques in road construction. Application of terrestrial laser scanning in the inventory of machines on the example of the turbine inventory (2 hours). Reliability optimization of the project of the horizontal implementation network (2 hours). Free alignment of the bifunctional implementation network in relation to the measurement location network determined by satellite techniques (1 hour).
		The use of geodesy in the rectification of road machinery, turbine sets, industrial robots, etc. Ship surveying: shipbuilding surveying services, monitoring of port quays deformation. The use of hydrostatic leveling in monitoring the deformation of a hydrotechnical object. Inventory measurements of target systems; mobile measuring systems. Designing special geodetic networks; evaluation of implementation networks established with GNNS techniques, hybrid implementation networks.Design exercises: Precise determination of wall surface deformation (diaphragm wall, facade fragment, retaining wall) by terrestrial laser scanning: scanning and tacheometric measurement (2 hours), - preliminary elaboration of the measurement results; alignment of the angular-linear network, georeferencing scans (3 hours), - detailed development of scans, preparation of deformation maps - use of software for processing point clouds from different manufacturers and comparison of the results of the final studies (3 hours).

Survey System Design	Construction and classification of geodetic measurement systems: control systems for construction machinery, geodetic measurements and displacement monitoring. Overview characteristics of objects subject to control measurements as a result of legal regulations and industry requirements, legal conditions for the implementation of control measurements: Construction Law , Water Law and relevant Ministerial Regulations and guidelines, water structures, masts, bridges and viaducts, hydrotechnical facilities such as: dams and reservoirs, buildings and structures that may pose a threat to life. Familiarization with the basic elements of measurement systems of selected companies of geodetic equipment. Measurement systems for typical buildings and structures – principles of construction, principles of operation, utility functions, system configurations and their use. Wired and wireless communication systems between the elements of the measuring system on the construction site. Geodetic universal instruments as potential basic components of measurement systems in hybridsolutions. Ultrasonic measuring systems for geometric elements. Systems used in geodetic instruments as stand-alone internal systems: TPS from Leica and TopSurv from Topcon Remote measuring systems RMS – construction, functions and classification. Measuring systems: MWall, Servo_TC, GeoRobot,TC-calc and others as external systems to perform selected measurement work. GeoSurvey system – its construction, functions and possibilities of conducting measurements, monitoring the operation of many measuring instruments.
	Principles of building integrated systems for conducting automatic measurement processes. Overview of examples of these systems: REX, GeoMoS-Leica, Multilloger-SiSGeo. Principles of construction and installation of measuring devices for displacement monitoring and data distribution systems. Techniques for the development and presentation of monitoring measurement results in automated systems. Hybrid measurement systems and videotachimetry. Precise hydrostatic level - principles of operation and demonstration. Discussion of the concept of the MarQR vision system for precise relative measurements. The exercises include:1. Familiarization with the communication system and the use of radiomodems, 2. Elaboration of intimate results of monitoring performed using the firmware of the total station TDA5005 3. Measurement and development of monitoring results, performed using TC-calc software and total station TRP1201+ 4. After measuring the geometry of the object using a measurement system implementing the RMS 5. Angular indenting method. Discussion of the measurement principle and demonstration of the equipment set for measuring magnetic repairs. 6. Presentation of the operation of the hydrostatic level. 7.Inclinometric measurements with the SisGeo instrument. 8. Development of a monitoring system design for a selected facility.
Mathematical Models for Displacement Surveys	LECTURE Specificity of mathematical models for displacement analysis. Classification of mathematical models used in displacement analysis - evolutionary outline and current state. Mathematical models for displacement analysis based on kinematic network model. Example of kinematic model for time-distributed measurements. Explanatory and input-output models. Kalman filter - assumptions and basic relationships. Concept of Perelmuter two-stage model. The essence of the "back analysis" approach. DESIGN EXERCISES 1. An example of application of one-epoch kinematic model of a network (horizontal network). 2. Application of Prof. Roman Kadaj's kinematic model to elaboration of observations in leveling network. 3. Practical example of using Kalman filter in displacement analysis.
Measurements of Displacements and Deformation	LECTURE Introduction to mathematical models used to study displacements. Kinematic model of a one-epoch network (uniform, rectilinear motion) and the application of this type of model in determining displacements. Relationships between the displacement components of a rigid body and displacements of its selected points. Transformations of the reference system: transformations for the displacement vector and transformations for the covariance matrix of its components. Approximation of the vector displacement field. Determination of the gradient elements of displacements. Introduction to strain gauge measurements in construction. Determination of horizontal deformations of the terrain on the basis of strain gauge measurements in star-shaped geodetic measurement structures. DESIGN EXERCISES - Application of the kinematic model of a single-stage control leveling network (uniform motion) to reduce the measurement results to a specific reference moment. - Calculation of the displacement components of the chimney foundation plate on the basis of vertical displacements of its selected points. - Determination of the elements of the horizontal strain tensor using the measurement structure in the form of a regular star.

	Seminar on Measurements of Displacements	The course covers current issues in the field of geodetic displacement measurements, published in Poland and abroad (mainly English-language studies). Topics are prepared by 1 or 2 people and presented in the form of a seminar with discussion after the topic has been presented, using modern multimedia techniques.
	Engineering Surveying Seminar	Familiarization with the principles of the implementation of the diploma thesis and the requirements set by the university. Discussion of the forms of implementation of the diploma thesis and ways of presenting the results. Discussing selected problems of graduates. Preparation for presenting the effects of the master's thesis from the two phases of the implementation of the topic. The first state - the work plan and the main parts of the work and its thesis, the second - the selected element of the most important work ready for presentation and discussion. These elements are agreed with the supervisors conducting master's theses
	Fieldwork in Engineering Geodesy	1. Geodetic construction service (4 hours) - stakeout and control works (classes on the construction site in the center of Warsaw, the exact location of the exercises varies depending on the current works carried out by construction companies cooperating with the Department of Engineering Geodesy and Measurement and Control Systems (m. including Warbud, Skanska, Soletanche) To familiarize students with the specificity of the work of a geodetic team during the construction of a multi-storey building, in particular: - staking out construction axes and detailed points, - stakeout control, - control measurements of the displacement of diaphragm walls, - transfer of height and control of the geometry of staircases, elevator shafts and technological openings, - control measurements of formwork and concrete columns. Taking measurements and preparing one of the above-mentioned geodetic tasks (the scope is agreed each time with the construction management). 2. Regulatory measurement of a part of a tram track in the area of a tram depot in Warsaw (3 hours) 3. Geodetic control measurements of the dam (4 hours) - topic carried out on the example of Dębe and Włocławek dams, overview and presentation: control measurements performed using the precision leveling method, - measurements of the deflections of the reservoir crown by the simple straight method (measurement performed by students on the visited facility), - relative deformation measurements - presentation of the ASTKZ system, - measurements of horizontal displacements (angular-linear network). 4. Measurements in mining (4 hours) - on the example of running an excavation in the Kłodawa salt mine (topic implemented in the form of a technical trip).
	Surveying Investment Management	Lecture: Legal conditions for land surveying services for investments: Geodetic Law, Construction Law, Water Law and relevant regulations. Economic activity in the field of geodetic investment management. Interpretation of inquiries for offers and specification of essential terms of contract (SIWZ) for geodetic works in the field of handling the investment process. Occupational health and safety regulations in force on the investment site, Hazard Risk Assessment (ORZ), Instructions for Safe Work Performance (IBWR). Geodetic technical standards in the field of construction service. Geodetic documentation for design purposes: including a map for design purposes in accordance with legal regulations from 2011. Application for geodetic work. Control of survey reports submitted to ODGiK. Design Document Reconciliation Team (ZUDP). Surveying project development (documentation, implementation and stakeout sketches).
		Construction log and geodetic execution entries. As-built inventory and technical requirements when accepting construction works. Measurements related to the examination of the dimensions of prefabricated elements, formwork positioning and positioning of façade curtains. Control measurements. Preparation of geodetic documentation for typical construction investments. Exercises: 1. Development of two measurement variants and their implementation - precise measurement of the difference in height (transfer of height) in the conditions of an engineering investment with difficult access to the facility and with the use of special techniques. 2. Development of the concept of a geometry control system for selected building elements: slab, beam, column, fitting, etc. 3. Measurement of the flatness of a prefabricated element with the use of a laser instrument realizing a vertical plane. 4. Development of a measurement and a program that performs calculations in real time for the task: setting elements in accordance with the given geometric conditions (eg windows, facade elements, prefabricated elements).

	Mechanics of Structures and Constructions	Lectures: 1. Basic definitions in the mechanics of structures and structures. Methods and assumptions of building mechanics. 2. Equilibrium of system forces. Bars and ways of their supporting. Static diagrams of construction elements. Rigid body degrees of freedom. Bonds and their influencing. 3. Trusses. Basic concepts and assumptions. Geometric invariance and static determinability of trusses. Non-working bars in the trusses. 4. Analytical methods in determining the value of forces in truss bars. 5. Basic concepts and types of material mechanics. Axial stretching and compression. Stresses and strains. Dimensioning of cross-sections. 6. Geometric characteristics of flat figures. Center of gravity and static moments of cross-sections. Moments of inertia. 7. Internal forces in the plane bar systems. The concept of longitudinal and traverse force and bending moment. Straight beams. 8. Determination of the value of internal forces and preparation of diagrams in straight beams. 9. Simple bending. Normal and tangential stresses. Section strength index. Shaping bending elements. 10. Statically determinate frames. General concepts. Determining the value of internal forces and drawing up diagrams within the framework. 11. Deformation of statically determinate beams. Determination of the deformation value using the Clebsch method. 12. Complex strength. Compression and eccentric stretching. Section core. 13. Axial compression, including lateral buckling. The slenderness of the bars. General rules for the design of bars. 14. Single-span statically indeterminate beams. 15. Completion of the course.
	Engineering Facilities Information Systems	1. Review of the selected information systems for various types of objects. 2. Elaborating the multimedia presentation about the information management system for the selected object (individual students or teams). 3. Development of the AutoCAD project (individual students).
	Analyses of Measuring Networks - Concepts and Methods	LECTURE The essence of preliminary accuracy analysis and its basic relationships. Accuracy versus internal compliance. Methods of eliminating or reducing influences interfering with theoretical model of random errors. Network defect. Free adjustment principle. Review of accuracy characteristics used in network analysis and their important properties. Methods of network referencing - ranked, stochastic (with different levels of accuracy data detail) and non-distorting connections.. Staking accuracy analyses (one-step staking and two-step staking). Reliability versus accuracy. Disturbance/response relationship in linear model. Unobservable disturbance space and its important properties. Indices of internal reliability of networks (uncorrelated observations). Internal reliability criterion (uncorrelated observations). Reliability theory as a conceptual foundation of engineering measurement design methodology. PROJECT EXERCISES 1. Preliminary analysis of the accuracy of determination of chimney axis deviation from vertical. 2. Comparative analysis of the effects of adopting different reference systems on the position of points in local horizontal measuring structures. Determination of internal reliability indices for considered variants of measuring constructions. 3. Referencing the horizontal measuring construction to points with given ellipses of the mean error.
	Diploma Seminar	Methodology of scientific work, guidelines for writing scientific texts and thesis. Putting a scientific thesis, the ability to verify it, selection of appropriate research methods, methods of presenting results. Review of literature sources, selection and analysis of literature related to the topic of the thesis. General overview of issues in the field of geodesy and cartography, including related topics with diploma theses undertaken as part of the SIP specialization, as well as accompanying issues, in particular in the field of intellectual property and copyright. Preparation and delivery of presentations presenting important stages of the implementation of the diploma thesis.