

Latvia University of Life Sciences and Technologies
FACULTY OF ENVIRONMENT AND CIVIL ENGINEERING

APPROVED
by the academic staff meeting of
Department of Land Management and Geodesy
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PHOTOGRAMMETRY

Jelgava

Programme

Code of the study course at LLU IS Register: **BūvZ4057**

4 CP (64 h): lectures 2 CP (32 h), laboratory works 4 CP (32 h)

Type of assessment: an examination with a grade

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Compulsory course of the full-time 1st level professional higher education Bachelor's degree level study programme "Land Management and Surveying" in 7th semester (1st semester, 4th year) of the Faculty of Environment and Civil Engineering.

Abstract:

The course of the subject "Photogrammetry" is designed for students with the aim to provide students with basic knowledge that would allow the use of the acquired knowledge and skills in different situations in their perspective jobs or professional activities in surveying, building construction works, real property, land management and other agricultural or forestry sectors. The program is intended for comprehensive training of cadastre, agriculture, forestry and other field specialists in rural area. Knowledge, acquired in learning process can be used in different land management authorities of Latvia, other state and municipality institutions (sectors of cadastre, physical planning, land use planning, real property taxation, formation and market valuation, agriculture, forestry etc.) and also the private sector.

The aim of the study course:

To train specialists of Latvian cadastre, real estate register, agriculture, forestry and other professions related to rural areas to become knowledgeable users of photogrammetric output results in different situations in their future professional practice. Lectures explain and develop understanding of production and use of photogrammetric output.

Learning outcomes (knowledge, skills and competence):

After completing the course students will have:

- **knowledge** and understanding about essence, contents, opportunities, necessity and usage of photogrammetry.
- **skills** – students are able to identify photogrammetric applications and opportunities in their future professional responsibilities, to define the assignments / orders for specialists of photogrammetry;

- **competence** – to evaluate the results of the received photogrammetric output and the compliance with the requirements for future intended use.

Relation of the study course with other subjects:

Students previously should have studied the study courses “Geodesy”, “Cartography”, “Mathematics”, “Physics”.

Requirements for individual work:

Studies of materials from the resources of the list of bibliography.

Procedure of assessment of knowledge:

1. Tests: 2
2. Examination in oral and written form based on the questions covering the material of the study course.
 - 2.1. 5 questions from a given topic;
 - 2.2. Evaluation in 10-point scale.
3. Prerequisites for taking an examination:
 - 3.1. Successfully passed tests;
 - 3.2. Attendance of classes at least 60%.

Procedure and requirements for settling missed lectures:

According to the procedure approved by the department.

Extended content of the programme

Definition, division of photogrammetry, historical overview:

Basic definition of the photogrammetry industry and its content and origin. Fundamentals, their meanings and functions in common photogrammetric processes. Photogrammetry classification, its origin and nature. Importance and opportunities in the national economy, links with other sectors and Geographic Information Systems (GIS). Historical overview of photogrammetry’s development. *Practical work with aerial photography: Definition of image scales using scanned images in ArcGIS and Benyley “Microstation” or “PHOTOMOD” or other related programme.*

Basic definitions and basic principles of photogrammetric activities, products:

The origin and nature of the name of the photogrammetry, the related basic definitions. Basic principles of photogrammetric activities – a technical aspect, conditions. Light: electromagnetic waves, radiation, spectrum and properties. Refraction. Light record / image samples. Results of photogrammetric work, products and their application. *Practical work with aerial photography - measurements using scanned images in ArcGIS or Benyley “Microstation” or “PHOTOMOD” or other related programmes.*

Remote sensing. Relation between photogrammetry and remote sensing:

Remote sensing, its definition and technological principles of operation. Components of remote sensing processes. The definition of remote sensing and photogrammetry, comparison of content of the work and the technology used. The relation among remote sensing, photogrammetry and GIS. Photogrammetric products and their applications. *Practical work with aerial photography - measurements using scanned images in ArcGIS or Benyley “Microstation” or “PHOTOMOD” or other related programmes.*

Geometric basics of photogrammetry:

Geometric basics of photogrammetric principles. Understanding of a scene scale. Distortion of distances, angles and areas in scenes. The origin and essence of the elements of the inner and outer orientation of the scenes. Understanding of coordinate systems in photogrammetry. The essence and meaning of the central projection. External orientation elements. Spatial rotation matrices. *Practical work with aerial photography images: recognition of objects in images and recording of objects in vector data formats using ArcGIS or Benyley "MicroStation" or "PHOTOMOD" or other related programmes.*

Optical fundamentals of photogrammetry:

Optical fundamentals of photographic processes, radiation flux. Light spectra and filters. Luminous flux recording processes. Optical circuit of photo process and correlations. The sharpness of the image and its factors - depth of field, diffraction, optical resolution, photographic resolution, contrast, image movement. Types of objectives and their significance. The basic structure of the camera - an optical circuit. *Practical work with aerial photography: image recognition and recording in vector data formats using ArcGIS or Benyley "Microstation" or "PHOTOMOD" or other related programmes.*

Photography and photogrammetry. Photography equipment:

The essence of photography – the process of photography. Photo scenes and photo pictures; Operation scheme and structure of a camera. Photography processes: understanding of photochemical processes, properties of emulsions; Cameras and their division. Aerial cameras. Shooting resolution. Impact factors on the quality of photography and the reduction of their negative effects - compensatory techniques. *Practical work: Planning photography for selected objects for the processing of terrestrial photogrammetry.*

Planning of photography processes in photogrammetry:

General scheme of process planning. Schedule of photography as part of the whole process of photogrammetric work. Requirements for obtaining scenes for interpretation purposes. Planning for photogrammetric processing. Terrestrial photography planning. Defining parameters of photos/ images. Selection of shooting distance and lenses. Photography equipment selection and its impact on the planning process. Conditions and calculations for selection of photography locations (or aircraft flight parameters). The dependency of the photographic plan on the intended / requested final result. *Practical work: implementation of the plan of taking photos of chosen objects and preparation of the photographed scenes for processing.*

Planning and organisation of aerial photography:

Defining aerial photography planning. Planning components. Aerial photography plan. Choice of parameters and calculations for taking photos. Determination of limitations and precision parameters. Planning and creating support points (installation - labelling). Choice of the time of the day to shoot. Planning examples. Arranging orders for photos. Aerial photography planning. *Practical work: using free-code photogrammetry software (or an affordable licensed program "PHOTOMOD") to create 3D models of photographic objects on a computer.*

Work with images in photogrammetric processes:

Understanding of the interpretation of the scenes. Basic tasks of photogrammetric processing. Photogrammetric treatment of one image. Scene transformation. Photogrammetric treatment of two images. Coordinate calculation and its correlations. Orientation of a pair of photographs. Coordinate calculation of a model. Understanding of an orthophoto map, the process of obtaining it. The results of photogrammetric processing of images. *Practical work: to perform creation of orthophoto image of photographed objects in a computer using a free photogrammetric software (or an affordable licensed programme "PHOTOMOD").*

Interpretation of aerial photo images and visualisation of results:

Interpretation process and its components. Interpretation factors. Interpreting methods. The use of stereoscopic effects in interpretive processes. Means of interpretation. Fixing the results of interpretation – types of recording, their principles. Division of image content, interpretation keys, methods of analysis. *Practical work: to evaluate the quality of the developed 3D models and orthophotos, to plan and execute the geodesic control measurement cycle. Match and evaluate results in the ArcGIS (or ArcScene) programme.*

Aerial triangulation:

Understanding of aerial triangulation (Photo triangulation). Spatial photo triangulation. Basic processes of photo triangulation. Understanding of the support point and cross-section measurements. Block smoothing methods, their comparison, precision and conclusions for use. GPS aerial triangulation. Determination of external orientation elements using GPS / INS technology. Summary - recommendations for work planning. *Practical work: to work out precise 3D models and orthophotos using control measurement results.*

Planning and implementation of aerial triangulation:

Aerial triangulation planning as part of aerial photography plan. Determination of essential requirements for aerial triangulation planning. Requirements for creating aerial triangulation blocks and factors influencing the results of photogrammetric processing processes. Output data for the influence planning and their effect on the result. Aerial triangulation peculiarities in the digital photogrammetry process. *Practical work: to perform planning of automated aerial photogrammetric or laser scanning data acquisition using dron-copter (on ArcGIS, or multi-station or PHOTOMOD)*

Photogrammetric instruments and technologies:

Classification of photogrammetry and its relation to the development of tools and technologies, its role in GIS. Periods of graphic, analog, analytical, and digital photogrammetry. Development trends of instruments and technologies. Passive and active sensors. Photography equipment overview and comparison. Photogrammetric image processing technology and technical equipment. Digital instruments and technologies. Software. Technological peculiarities of photogrammetry production in digital image processing processes. *Practical work: to participate in the implementation of the prepared automated aerial photography or laser scanning data acquisition planning using dron-copters.*

Digital photographs in photogrammetric processes:

The peculiarities of digital image design. Image scanning technologies. Resolution and precision. Restrictions on digital image transfer and processing possibilities. Understanding of digital orthophoto. Orthophoto rectification process. Understanding of image interpolation in photogrammetry, interpolation methods. Image comparison technologies, techniques and their applications. Epipolar constraints. *Practical work: Initial processing of aerial or laser scanning data and data export to ArcGIS (ArcMap or ArcScene).*

Introduction into digital photogrammetry:

Specific differences between digital photogrammetry and classical photogrammetry. The use of drones. Changes in the technological scheme of work related to the use of digital images. Advantages and their influence on photogrammetry processes and results. Digital orthophoto map and its definitions. Orthophoto generation, technological scheme. Understanding of 3D file creation and usage. Digital height models. Automatization in digital photogrammetry processes. *Practical work: development of orthophoto and 3D terrain model and control of results, assessment.*

The latest equipment: digital cameras, photo scanners and laser scanners:

The development of digital technologies in image acquisition processes - the latest digital cameras and their characteristics. Latest digital aerial photography camera kits / complexes and their features, possibilities. Photo scanners and photo scanning systems (including aerial scanners) - their principal activity scheme, parameters, options.) Technologies of laser scanners (LIDAR) and their practical realization equipment (technical equipment), possibilities, parameters, operational characteristics. Prospective end products and areas of their applications. Equipment development prospects and possible outcomes.

Practical work: Arrangement of a report (ArcGIS) and a presentation of the results of completed measurements, decryption works, as well as the development of orthophoto and 3D terrain models.

Bibliography**Compulsory reading:**

1. Valdis Vanags, Mūsdienu Latvija topogrāfiskās kartes, Fotogrammetrija. VZD, Rīga, 2003, 275 lpp. (Textbook "Photogrammetry" by Valdis Vanags, publisher "Latvian State land service" in 2003).
2. „Ģeomātikas pamati”studiju kurss RTU 2006 g. (“Fundamentals of geomatics” (Ģeomātikas pamati) study aid at RTU (Riga Technical University) 2006).
3. Mācību grāmata „Ģeodēzija”, izdevējs „Latvijas ģeotelpiskās informācijas aģentūra”2007 g. (Textbook “Geodesy” publisher “Latvian geospatial information agency” in 2007).
4. Legislative acts of Republic of Latvia “Ģeotelpiskās informācijas likums” (Law of geospatial information), 2009;

Further reading and sources of information:

1. Karl Kraus, Photogrammetrie, Band I, Grundlagen und Standartverfahren, Dummler/Bonn, 1998, 450 lpp.

Recommended periodicals:

1. www.isprs.org
2. www.eurosdri.net
3. žurnāls "Mēriņķs"