

APPROVED

by the academic staff meeting of
Department of Land Management and Geodesy
February 6, 2018

GEOGRAPHIC INFORMATION SYSTEMS

Jelgava

P r o g r a m m e

Code of the study course at LLU IS Register: **Geog4002**

2 CP (32 h): lectures 1.0 CP (16 h), laboratory works 1.0 CP (16 h).

Type of assessment: Formal Test with a grade

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Compulsory course of the professional Bachelor's degree level study programme "Land Management and Surveying", 1st year 2nd semester in full-time studies and 3rd year 5th semester in part-time studies.

Abstract:

The study course "Geographic Information Systems" is designed to provide students with basic knowledge that would allow them to understand the possibilities of using the spatial information system and the expected results of use in their prospective professional activities in surveying, construction, real estate, land management and agricultural or forestry sectors. The course is designed for providing comprehensive knowledge for prospective cadastral, agricultural, forestry and other specialists working in rural areas which can be used in various land management authorities of Latvia, other state and municipality institutions (e.g., cadastre, physical planning, land use planning, real estate taxation and registration institutions as well as real estate market valuation, in agricultural, forestry sectors etc.), in the private sector.

The aim of the study course:

The aim of the course is to train specialists for work in institutions of Latvian cadastre, real estate registration, agricultural and forestry sectors in rural areas as knowledgeable users of functions and products of the Geographic Information Systems in different situations. Lectures focus on functioning, formation, maintenance and use of Geographic Information Systems. Students acquire initial skills in working with the Geographic Information System software.

Learning outcomes (knowledge, skills and competence):

After completing the course students will have:

- **knowledge** and understanding of the definition, development history, structure, possibilities, necessity and use of Geographic Information Systems.
- **skills** to be able to identify geographic information system application possibilities, define work tasks and requirements for Geographic Information Systems designers and administrators. Students have initial practical skills to use Geographic Information Systems and their software products, when performing their professional duties.
- **competence** to know the possibilities of Geographic Information Systems and to be able to perform initial basic user assessment of the available geospatial information services and products, to determine their relevance, applications, their professional functions or performance needs.

Relation of the study course with other subjects:

- The course is in relation to the study course “Mathematics” Mate1034.
- The study course provides an opportunity to acquire more purposefully the courses “BūvZ1041 Geodesy” and “BūvZ2051 Geodetic Networks”.

Requirements for individual work:

Individual studies of the theoretical material included in the bibliography. Tasks of the practical works.

Assessment of knowledge:

1. Two tests.
2. The procedure of the formal test: written and oral form of answering questions included in the test's paper:
 - 2.1. Five questions from one of the topics;
 - 2.2. Evaluation in 10-point scale.
3. The type and procedure of the formal test:
 - 3.1. Successful result of the answers to the theoretical questions in tests;
 - 3.2. At least 60% attendance.
 - 3.3. Completed and passed tasks of practical works.

Procedure and requirements for settling missed lectures:

According to the procedure approved by the department.

Extended content of the programme

The definition and significance of Geographic Information Systems (GIS):

Basic definitions of Geographic Information Systems, its content. The relation between the nature of definitions and the development of perceptions about basic components, applications and functions in the overall process of designing and operating the system. The parts of a GIS, components, origins, functions and connection with development of related systems. Significance and opportunities of applications in the national economy, connection with other sectors.

Practical work with ArcMap (ArcGIS) software: GIS workstation and its functions.

Creation and Development History of Geographic Information Systems:

Explanation of the origin and nature of the name of the Geographical Information Systems, the impact of the related industries and their development on the GIS history / development of GIS. Basic principles of system building and their developmental

history. An impact of the development of technical and technological possibilities on the development of the functions and performance of GIS. The development of the application possibilities and the current level of functionality.

Practical work with ArcMap (ArcGIS) software: Getting started with finding and adding data to the project.

Structure / components of geographic information systems and their functions:

Functions of systems' basic components in the context of overall operation. The tasks of the system and its components from the user's perspective. Division of Geographic Information Systems - according to different criteria for their assessment and feasibility. Conditions for creation of a GIS and its intended use. The interaction of system components in the processes of use and the critical positions of their operation ability. Suitability of the system structure parameters in accordance with the fulfillment of specifically defined tasks. *Practical work with ArcMap (ArcGIS) software: Searching data in the web and the Internet, adding them to the project including using ArcCatalog, ArcGlobe.*

Geographic Information Systems in Latvia (Including legislation, terminology):

Practice of GIS implementation in Latvia - a review and analysis of history and practice. The impact of international practices and standards on system implementation and development processes. The impact of national legislation on the GIS creation and operation in Latvia. Legislative acts, rules and regulations. Geospatial Information Law of the Republic of Latvia: evaluation of the law's influence on the design and use of systems. Terminology. *Practical work with ArcMap (ArcGIS) software: processing of the input data.*

Geographic information as the basis for geographic information systems:

Information, digital information, spatial information and digital spatial information, their common and distinctive features. Explanation of differences in the structure of general digital information and spatial information, technical methods of their implementation. Classification of spatial information and their characteristics. Geographic information as a source of spatial information. The place and role of geographic information in the geographic information system. Types and kinds of geographic information, their differences and unifying features for use in information systems. Evaluation of effectiveness and potential use various geospatial data. *Practical work with ArcMap (ArcGIS) software: evaluation of the data and their processing possibilities, including the use of ArcCatalog, ArcGlobe.*

Technologies for obtaining and processing geographic information:

Sources of geographic information and types / kinds of information to be obtained. The most commonly used technologies for obtaining information, their products and basic characteristics. Information processing technologies: their description and products to be obtained. Technologies for obtaining and processing information, their application in relation to the application purpose of information systems. Geodetic technologies and their application. Cartographic technologies and their application. Photogrammetry and remote sensing. The evaluation of the application efficiency of different technologies in relation to the objectives of the system being developed. The basic conditions to be applied for the use of any technology - the process of obtaining data from the geographic information system. *Practical work with ArcMap (ArcGIS) software: Transformation of acquired data into a single coordinate system.*

Technical equipment of geographic information system:

The process of general data processing of the GIS and the necessary technical support. Groups of technical equipment elements and their tasks for the operation of the system. Technical equipment variations depending on the tasks and functions of the system. Groups of technical equipment and their most relevant specifications of use. Basic requirements for technical equipment in geospatial information systems. Geographic Information Systems, comparison of specifications of technical equipment, operating principles and grounds for their selection. *Practical work with ArcMap (ArcGIS) software: the transformation of the obtained data in unified data formats.*

Geographic Information System software:

Principles, tasks of the basic software (special and professional) of Geographic Information Systems, their structure and operation. Support systems and their functions. Other software and applications. A list of the most commonly used special software products and their functionality comparisons. Specific software product requirements for technical support and personnel, as well as their purchase and maintenance costs. The basics for choosing a software suite when designing a geospatial system for a specific task. Knowledge of the software products necessary for the user of the Geographic Information System; initial skills in their use. *Practical work with ArcMap (ArcGIS) software: processing the obtained data, visual changes, selection of data, creation of work packages and settings, incl. using ArcCatalog, ArcGlobe.*

Geodesy and Geographic Information Systems:

The importance of geodesy in the design and functioning of Geographic Information Systems. Different geodetic reference systems, their interconnection possibilities and necessity within the framework of one system. Revision of the material on the nature, features and projections of geodetic reference systems. List of geodetic systems currently used in the world and their distinctive features. Understanding of geodetic transformations and transformation tools (software or their modules). The methodology for the identification of different geodetic systems in GIS systems and the choice of suitable transformation tools / methods for data matching. Understanding the criteria for data accuracy in terms of using geographic information systems. *Practical work with ArcMap (ArcGIS) software: manipulation of data tables, selection of necessary information in tables, editing, splitting and merging of tables.*

Cartography and Geographic Information Systems:

Cartography - one of the main disciplines of the collection and processing of Geographic Information Systems. Cartographic and geographic information: a transition from a map to geographic data sets. The similarities and differences of the data of the cartographic and geographic data (information) and Geographic Information System. Cartographic production process as the basic model for obtaining geographic information.

The peculiarities of cartographic production processes and their adaption for creating geospatial data. Quality processes in cartography and the role of their adaptation in geospatial data processes. Photogrammetry and remote sensing as source information. Interpretation in cartography and GIS. Cartography regularities and methods for

designing GIS analysis products and output maps. The creation and manipulation of geospatial data, the influence of cartographic regularities on the results and quality. *Practical work with ArcMap (ArcGIS) software: Basics of cartographic imaging and printouts.*

Possibilities of geographic information analysis and their processes for users of Geographic Information Systems;

Understanding geographic information analysis, its essence, possibilities. Geographic information analysis methods. Products of geographic information analysis and their application. Impact potential of the results of analysis products on decision-making processes and management effectiveness. A traditional scheme of analysis processes in geographic information systems, the basic conditions for its qualitative implementation. The results of the analysis for the process of creating new or derived information. Options of professional and amateur user analysis and their corresponding analysis tools. Analysis results, product design tools and options. Preparation of traditional maps as a result of the processing and analysis of information system data.

A summary: recommendations for planning analysis. *Practical work with ArcMap (ArcGIS) software: cartographic image creation, designing of multi-data set of image sets.*

Basics of designing and maintaining geographic information systems:

Definition of target task for creating a GIS as the basis for system planning. Introduction into the methodology of defining the system's minimum parameters. The definition of system components' parameters and determination of their mutual balance. The impact of the available technical equipment, software and available specialists' qualifications on system design planning. Data, data volumes, the impact determination of their initial parameters on hardware parameters and requirements of data transmission networks. Sources for obtaining or supplying data and other features: an impact on the operation of the system. The number of users, their capacity and requirements. Other impact factors. A summary: recommendations for planning a system or monitoring planning. *Practical work with ArcMap (ArcGIS) software: cartographic image design, creation of printouts for plotters and printers, test results and correction. Creation of raster image formats.*

Geographical information metadata - definition, structure, application and meaning:

Understanding metadata, their essence and definitions. Metadata tasks in the information system. General principles of structure of metadata, their division. International and national standards for metadata, their structure, quality and use. Search options using metadata. Metadata filling technology, responsibility and availability. *Practical work with ArcMap (ArcGIS) software: the basics of data analysis operations.*

GIS data matching (interoperability), meaning, challenges to system functionality:

Understanding GIS data matching (interoperability), in information systems. The essence of data matching (interoperability), its necessity and purpose in the real world of data. The sources, origin and effects of data matching (interoperability) on the information analysis processes. The classification of sources of shortcomings and the

possibilities for their elimination. Requirements of international and national standards and regulations for data matching (interoperability), as well as responsibility for their implementation.

Real-time technologies for implementation of data matching (interoperability) security requirements. The simplest methods to measure data quality and interoperability by performing the evaluation of available data. *Practical work with Arc Scene (ArcGIS) software: Introduction to 3D data and basic activities with them.*

Introduction to the organization of the information analysis process using the Geographic Information System:

Application of traditional information analysis process scheme in geospatial data analysis processes. The geospatial information analysis process scheme and its differences from the traditional analysis process. The benefits of a GIS in the results of the analysis process. Additional efficiency of the analysis results. The basic activities and their methods using the specific features of the GIS programme in the analysis. Specific possibilities for presentation and demonstration of results. Possibility to use the analysis results in operational process management in almost real-time mode. The conditions for efficient information analysis and process management using GIS. *Arc Scene (ArcGIS) software: Laser scanning data input (from a drone-copter), and main activities with them, design of the relief.*

Current use of geographic information systems in the national economy and prospects for GIS applications:

GIS application and application examples in the present stage of development. Geographic information systems created or used in Latvia or their equivalents and a brief overview of their functionality. International systems known to the wide public, their development and usability information. Presently implemented and not implemented coverage of the use of similar system services in Latvia on the whole. Worldwide standardization trends and their impact on volumes of use. Development prospects in the near as well as far future. Prospective end products and applications. *ArcMap (ArcGIS) software: Input of personalized data (surveying, remote sensing or photogrammetric), transformation into a single environment, implementation of the theme of the chosen analysis and formatting of the results in a map printout format.*

Bibliography:

Compulsory reading:

1. „Ģeomātikas pamati” studiju kurss RTU 2006 g.
2. Stūrmanis E. Ģeoinformācijas sistēmas: māc. līdzeklis. LLU, RTU. - Jelgava, 2006. - 90 lpp.
3. Tor Bernhardsen. Geographic Information Systems, 1992.
4. Цветков В. Геоинформационные системы и технологии, 1998.

Further reading and sources of information:

1. Karl Kraus, Photogrammetrie, Band I, Grundlagen und Standartverfahren, Dummler/Bonn, 1998, 450 lpp.
2. Valdis Vanags, Mūsdienu Latvija topogrāfiskās kartes, Fotogrammetrija. VZD, Rīga, 2003, 275 lpp.
3. Mācību grāmata „Ģeodēzija”, izdevējs Latvijas ģeotelpiskās informācijas aģentūra, 2007.

4. Grāmata „Kartogrāfija” no sērijas Mūsdienu topogrāfiskās kartes izdevējs VZD, Rīga 2002.

Recommended periodicals:

1. www.isprs.org
2. www.eurosdri.net
3. žurnāls “Mērnīeks”
4. Envirotech, Ģeogrāfiskās informācijas sistēmas, www.gis.lv