**“Geographic Information Systems”**

**Syllabus CT.06/1**

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Version 1

# Name of the course

**Geographic Information Systems**

# ECTS credits

6 Credits, **(45H Theory; 30H Lab), 1st semester**

This lecture provides students with basic knowledge in the field of analytical use of geographic information systems. The lectures should acquaint students with GIS technologies, teach to use the most widely used GIS tools and prepare students for implementation of GIS tools in practice and in management of private companies and state administration.

# Objectives

The main objectives of this lecture are following:

* Basic terminology and basic concepts in the field of GIS.
* Geographic environment modelling - the modelling of geographic environment is shown.
* Geo-object modelling - basic approaches to modelling spatial objects.
* Raster layers, scatter surfaces, digital terrain models and their different representation.
* Geographic (GIS) databases - Different generations of GIS from the point of view of database systems.
* Input of geo-data, basic data restructuring - primary and secondary sources of geographic data, field surveys, etc.
* Analysis (in raster format) - analysis of geographic data as the main purpose of GIS, geodatabase queries, reclassification and map algebra, distance analysis, height analyses.
* Analysis (in vector format), image analysis - network analysis, traffic access zone to the service centres.
* GPS and GNSS - technical parameters, description of the principle, extended GPS (DGPS).

# Learning outcomes

The general expectation regarding the knowledge to be provided/acquired is as follows:

* independent analytical work in the field of geographic data processing for the purpose of their cartographic visualization in both electronic and analogue form, with the ability to automate their work;
* solving more complicated geographic and cartographic problems in practice;
* work with geographic information systems to solve specific problems of application character;
* creation and use of digital and analogue topographic and thematic maps;
* creative use of the GIS, GNSS and other ICT techniques.

# Contents

1. INTRODUCTION

1.1 Definition of the term GIS

1.2 History of GIS deployment

1.3 Introductory terms

1.3.1 Relationship between GIS and modeling theory

1.3.2 Space and geo-object

1.4 Major GIS users and their fields

1. THE BASIS OF GEOINFORMATICS

2.1 Geo-space modelling

2.1.1 Replacement ellipsoids

2.1.2 Earth body

2.2 Coordinate systems

2.2.1 The Euclidean Metric

2.2.2 Introduction to geographic coordinate systems

2.2.3 Wide-length system (WGS-84)

2.2.4 S-JTSK

2.2.5 Gaus/Krüger mapping and UTM

1. REPRESENTATION OF SPATIAL OBJECTS

3.1 Specifics of spatial objects

3.1.1 Spatial object dimensions

3.1.2 Spatial resolution, scale

3.1.3 Spatial processes

3.2 Map layers

3.3 Raster and vector - representation of the map layer

3.4 Spatial relations between geoobjects

3.5 Vector representation of spatial objects

3.5.1 Vector models

3.6 Raster representations of spatial objects

3.6.1 Geometry and raster topology

3.6.2 Data compression methods

3.6.3 Restructuring raster data

3.7 Typical use of raster and vector

3.8 Digital Terrain Models (Surfaces)

1. GIS DATABASE SYSTEMS

4.1 Data stored in GIS

4.2 Current state of the GIS database support technologies

4.2.1 Storing the vector by the file style + table

4.3 Development: Post-Relational Database

4.3.1 PostGIS and PostgreSQL

4.3.2 Comparison of the relational and postrelational database for GIS

4.4 Specialities in data saving

4.4.1 Raster in pyramid storage

4.4.2 Geotiff format

4.5 Comparison of the current state with the object model

1. INPUT DATA IN GIS

5.1 Introduction

5.2 Primary data sources

5.2.1 Geodetic measurement

5.2.2 Photogrammetry and photointerpretation

5.3 Secondary data sources

5.3.1 Digitalization of map background

1. ANALYSIS IN RASTER AND VECTOR FORMAT

6.1 Spatial and database queries

6.2 Grid analyzes

6.3 Overlay map layers

6.4 Distance analysis

6.5 Terrain model analysis

6.6 Network analysis

6.7 Image analysis

1. NAVIGATION SYSTEMS

7.1 Introduction

7.2 Navigation needs

7.3 Principle of satellite navigation - trilateration

7.4 GPS satellite navigation

7.5 Differential correction

1. EXCERCISES

8.1. Getting acquainted with GRASS - basic operations, listing map layers, monitors, layer display, imaging region settings, distance measurements. Selection of selected parts of the layers.

8.2. Data input - georeferencing of the specified image, vectoring of selected image partitions, acquisition of attribute data, management of the GRASS database part.

8.3. Grass analysis - as a background, demonstration datasets from GRASS (spearfish, leics) are used. Due to the fatal lack of vector data, vector-based analyses are not undertaken.

8.4. The basics of working with ArcGIS (in preparation) - introduction to ArcEditor from ESRI, including all basic GIS operations.

8.5. Generating map output in ArcGIS - processing the result of analyzes in the form of publishable map delta.

# Teaching method

Lectures, case studies, tutorials/exercises

* The slides are available for the whole course. They are provided to students (or uploaded in the MOODLE system). The full contents of each slide is systematically explained by the Lecturer. Additional examples which are not included in the slides are proposed by the Lecturer to allow good understanding of the information provided.
* The slides contain exercises with solutions for the good understanding of the content of each chapter. These solutions are systematically explained (during the lecture) by the Lecturer.
* The slides contain also exercises without solutions. They should be solved by students during the lecture (this is part of oral exam). The students are fully assisted by the Lecturer in order to obtain correct/exact solutions to the proposed exercises. This should help to check whether the students have understood the chapters or not.
* Several exercises are proposed by the Lecturer to be solved by students as projects. This should help to test the self-learning potential of students.

# Assessment method

Mid-term and final oral and/or written examination, exercises from case studies.

# Textbooks - Publications - Software

**Textbooks**

* Jeff Thurston, Thomas K. Poiker, J. Patrick Moore: Integrated Geospatial Technologies: A Guide to GPS, GIS, and Data Logging.
* Roger Tomlinson: Thinking About GIS: Geographic Information System Planning for Managers.
* Harlan Joseph Onsrud , David W. Cook: Geographic and Land Information Systems for Practicing Surveyors: A Compendium
* Paul A. Longley, Michael F. Goodchild: Geographical Information Systems: Principles, Techniques, Management and Applications
* Otto Huisman and Rolf A. de By: principles of GIS
* Historical GIS : technologies, methodologies and scholarship / Ian N. Gregory, Paul S. Ell.

**Selected relevant Publications**

* Ian N. Gregory, Paul S. Ell.: Historical GIS : technologies, methodologies and scholarship
* https://learn.arcgis.com/en/educators/
* http://www.esri.com/esri-news/publications
* https://www.gislounge.com/gis-magazines/

Software

* AutoCAD MAP – GIS
* Modelica and ArcGIS. Software of ArcGIS
* Arc Editor of ESRI company
* Spatial Analyst or 3D Analyst
* GRASS - Geographic Resources Analysis Support System
* QGIS – free software